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# An approach to quantify sources, seasonal change, and biogeochemical processes affecting metal loading in streams: Facilitating decisions for remediation of mine drainage

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abstract

Historical mining has left complex problems in catchments throughout the world. Land managers are faced with making cost-effective plans to remediate mine influences. Remediation plans are facilitated by spatial mass-loading profiles that indicate the locations of metal mass-loading, seasonal changes, and the extent of biogeochemical processes. Field-scale experiments during both low- and high-flow conditions and time-series data over diel cycles illustrate how this can be accomplished. A low-flow experiment provided spatially detailed loading profiles to indicate where loading occurred. For example, $SO_4^{2ffi}$ was principally derived from sources upstream from the study reach, but three principal locations also were important for $SO_4^{2ffi}$ loading within the reach. During high-flow conditions, Lagrangian sampling provided data to interpret seasonal changes and indicated locations where snowmelt runoff flushed metals to the stream. Comparison of metal concentrations between the low- and high-flow experiments indicated substantial increases in metal loading at high flow, but little change in metal concentrations, showing that toxicity at the most downstream sampling site was not substantially greater during snowmelt runoff. During high-flow conditions, a detailed temporal sampling at fixed sites indicated that Zn concentration more than doubled during the diel cycle. Monitoring programs must account for diel variation to provide meaningful results. Mass-loading studies during different flow conditions and detailed time-series over diel cycles provide useful scientific support for stream management decisions.

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## 1. Introduction

Many years of historical mining near Silverton, Colorado have left aboandoned mines and mining wastes that contribute metal loads to the Animas River. This situation is typical of hundreds of catchments affected by mining throughout the world, and leaves land managers with difficult decisions about remediation in complex systems where multiple sources of metals within a single catchment may contaminate the stream. Land managers must have reliable scientific information to support their decisions. To meet some of these information needs, the US Geological Survey has developed a mass-loading approach that focuses on metal loading to a stream through development of detailed spatial profiles of stream discharge and chemistry. The mass-loading approach has many applications, including the study of hydrologic characteristics of streams (Bencala, 1993; Bencala et al., 1990; Broshears et al., 1993; Gooseff et al., 2005; Harvey and Bencala, 1993; Zellweger, 1994), the determination of likely sources of metals and other constituents (Boughton, 2001; Kimball et al., 2002, 2005, 2006, 2007; Kimball and Runkel, 2009; Nimick and Cleasby, 2001; Walton-Day et al., 2005; Wirt et al., 2001), the estimation of pre-mining chemistry of watersheds (Runkel et al., 2007; Kimball et al., 2009), and quantification of biogeochemical reactions (Harvey and Fuller, 1998; Kimball et al., 1995; McKnight et al., 2001; Runkel et al., 1996, 1999).

In general, the approach is based on two established techniques: the tracer-dilution method (Kilpatrick and Cobb, 1985; Bencala et al., 1990) and synoptic sampling (Bencala and McKnight, 1987). The tracer-dilution method provides estimates of stream discharge that are used to quantify the amount of water entering the stream within a given stream segment through both tributary and groundwater inflow. Synoptic sampling of stream and inflow chemistry provides a spatially detailed 'snapshot' of stream-water quality and the inflows that influence changes along the stream. Discharge and chemistry are combined to provide quantities of loading (mass per time) to provide information about the extent of metal input and to support decisions about remediation.

Mass-loading studies in the Animas River basin (Church et al., 2007; Kimball et al., 2002, 2007) have provided detailed

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information about the locations of metal loading to a stream during low-flow conditions when mine drainage is the least diluted and can be most harmful to aquatic organisms (Besser and Leib, 1999). During low-flow, the longitudinal profile of the stream chemistry might be considered to be relatively constant, meaning that discharge varies spatially and not temporally. Also, it means that changes along the study reach are a result of constant inflow sources to the stream and processes that affect solutes at constant rates. Although exceptions to this steady-state condition could occur through diel variations (Gammons et al., 2005; McKnight et al., 1988; Nimick et al., 2003), the sampling attempts to minimize these effects. Thus, low-flow conditions permit the evaluation of the relative contribution of many sources and their impact on the stream.

Application of the mass-loading approach to high-flow conditions could provide valuable information on seasonal or transient sources of metals that may increase toxicity. During high-flow, constant conditions no longer apply, and the longitudinal profile of stream chemistry will vary temporally. To study spatial changes subject to temporal variation, two possible approaches are presented. First, a Lagrangian sampling attempt to follow the same parcel of water along the study reach, sampling as the parcel is sequentially affected by inflows and in-stream processes. A second approach involves a sequence of samples at fixed locations, providing a time series of chemical data at individual sites along the stream. This approach can be much more sample-intensive than the Lagrangian sampling.

Fey et al. (2002) sampled the "spring thaw conditions" at the USGS gaging station 09359020, downstream from the location of this study reach, and downstream from both Cement Creek and Mineral Creek, two metal-rich streams (Wright et al., 2007). Fey et al. (2002) indicated trends in the early, and most likely, low-elevation runoff that were consistent with results from this study. However, it did not address the approach of low- and high-flow synoptic sampling, and the toxicity results from the Fey et al. (2002) study were strongly influenced by the metal-rich inflows downstream from the current study reach. To expand on the earlier study, and to evaluate low- and high-flow mass-loading approaches, two field experiments were designed along the reach of the Animas River, upstream from the confluence with Cement Creek. The first experiment was in August 2002, during a period of extreme low flow. The second experiment was in April 2003, during a period of higher flow in response to low-altitude snowmelt runoff before peak runoff. This snowmelt drains areas of mine waste and tailings away from the stream. The study reach began upstream from Arrastra Creek and ended at Silverton (Fig. 1), a shorter study reach than that of Paschke et al. (2005). This discussion will focus on the results for pH, $SO_4$, Fe, Cu, Mn and Zn. The field experiments will show how the mass-loading approach can help support remediation decisions in three ways. First, the approach provides a quantitative assessment of the metal loading profile along a reach, allowing the identification of the greatest loads. Second, it quantifies seasonal variation in mass-loading profiles between low- and high-flow conditions. Third, it quantifies important biogeochemical processes that affect the transport of metals and that should be considered in designing monitoring programs.

## 2. Methods

The description of methods includes the specific tracer-dilution methods applied to both low- and high-flow studies, the separate sampling designs applied to each, and the common processing and analytical methods used for both studies. Also, the multivariate methods used for data analysis are explained.

### 2.1. Tracer-dilution

A tracer-dilution approach to quantify discharge has been applied to many hydrologic and solute-transport studies (e.g., Gooseff et al., 2002; Briggs et al., 2009). The equations and methods used for tracer-dilution discharge apply to both the low- and high-flow studies. These equations have been discussed in Kimball et al. (2002) for their application to studies of mine drainage and also are available on-line (Kimball et al., 2007; http://pubs.usgs.gov/pp/1651/downloads/Vol1_combinedChapters/vol1_chapE9.pdf).

For both studies, several batches of the NaBr tracer salt were dissolved in stream water in a large plastic garbage can using a fixed salt to stream water ratio each time. Each batch was pumped into an agricultural tank to make up the required volume of injection solution. From the tank, the brine was pumped into the stream using Fluid Metering QB positive displacement piston pumps, modified with rotational sensors. The pumps were controlled by a Campbell Scientific CR10X data logger to count pump revolutions and maintain a constant pump injection rate over time as field battery voltage declined. The injectate concentration for the low-flow study was 227,200 mg/L Br and the pump rate was 187 mL/min. For the high-flow study, the tracer concentration tracer was 247,500 mg/L Br and the pump rate was 404 mL/min. These gave a Br mass-flow of 708 mg/s for low flow and 1670 mg/s for high flow. After running the injection for a sufficient time to reach a constant concentration at all points downstream, discharge could be calculated for each stream sampling site based on the sampled Br concentration. This discharge provided the necessary hydrologic context for the low- and high-flow studies, and the different sample designs for the low- and high-flow sampling.

### 2.2. Sampling and analysis

Synoptic sampling, literally meaning a view of the stream at one point in time, provides the means to characterize the spatial distribution of metal sources, and where sources may contribute load to the stream. A list of the sampling sites is given in Table 1. The low-flow synoptic experiment included 27 stream sampling sites and 18 inflow sites. In contrast, the high-flow synoptic experiment only included seven stream sites and 14 inflow sites. Possible inflow sampling sites during high flow were more numerous because of overland flow to the stream from snowmelt runoff, but logistically not all inflows could be sampled. Major inflows from the low-flow study were re-sampled during high flow (Table 1), but because many more inflows were present than were sampled, the effects of snowmelt runoff had to be defined by in-stream changes. During the high-flow study, auto-samplers operated for about 28 h at six stream sites (Table 1).

For low- or high-flow sampling designs, each stream site represents the downstream end of a stream segment. These segments divide the watershed into increments to account for in-stream and inflow loads (Kimball et al., 2002, 2007). During high-flow conditions, fewer stream sites can be sampled, so the length of stream segments and the number of sampled inflows can differ substantially between the designs. For either situation, however, changes in stream chemistry and discharge between stream sampling sites reflect a net change in metal load for specific segments. Because more than one source of metals might drain into a particular stream segment, individual sources cannot always be quantified at this stream reach scale. Sample designs for synoptic sampling differed for low- and high-flow conditions, and will be detailed separately.

#### 2.2.1. Low-flow sampling

Under ideal conditions at low flow, samples at all of the sampling sites would be collected simultaneously, providing a descrip-

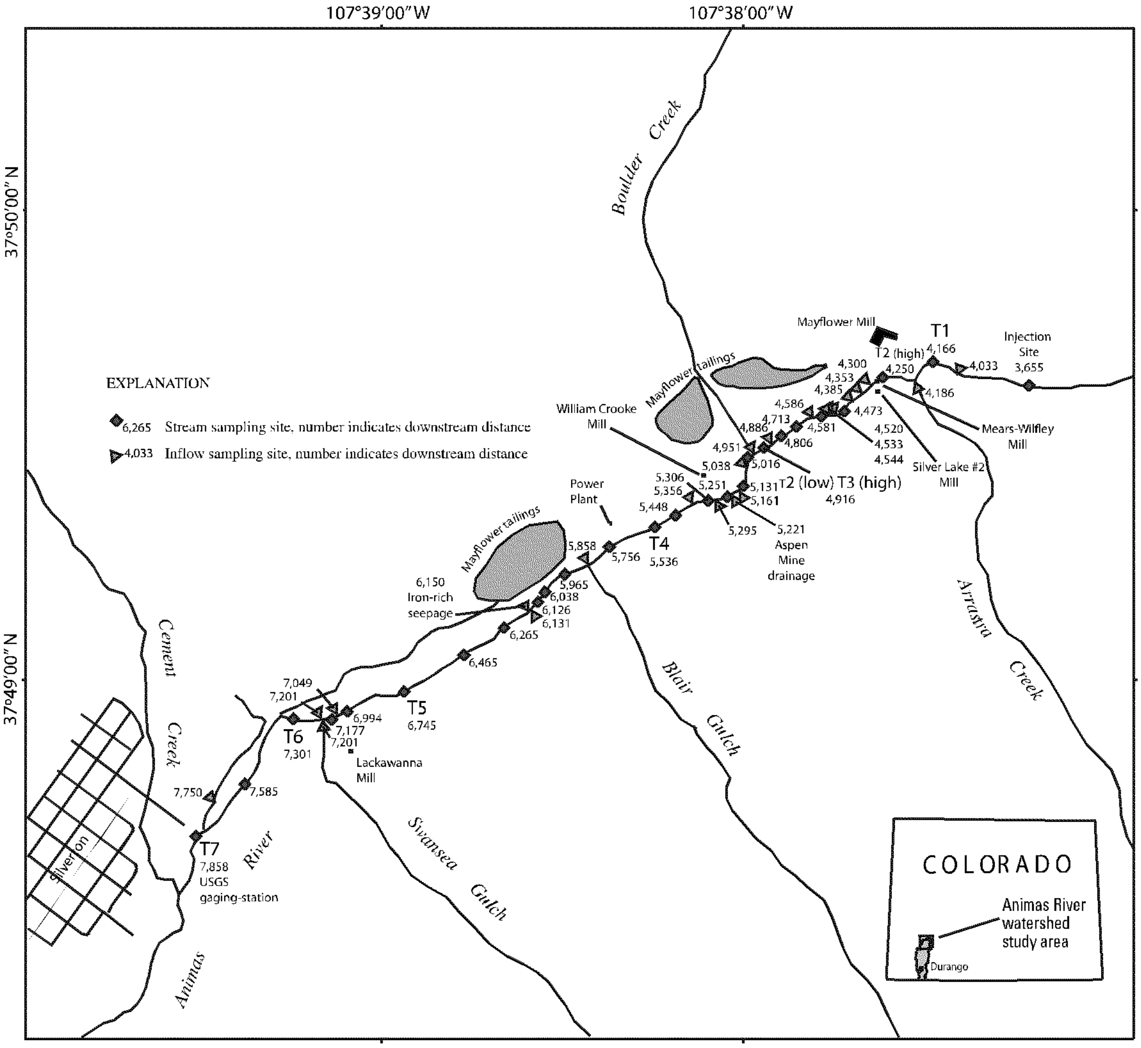


Fig. 1. Location of study reach and sampling sites along the Animas River, August 2002 and April 2003. All sites were sampled in 2002, but only the transport sites (T1–T7) were sampled during high flow in 2003 (see Table 1).

tion of stream-water quality under relative steady conditions. Personnel limitations precluded simultaneous sample collection for so many sites. The low-flow synoptic study, however, is accomplished over a relatively short time (usually less than 8 h) in an effort to minimize effects of diel flow variation. Sampling at low flow can begin when the tracer concentration has reached a relatively constant concentration over time. The assumption of constant conditions for the tracer can be affected by diel variations due to evapotranspiration, but in general, this diel variability only affects tracer concentrations when stream flow is less than a few liters per second. Because the sampling includes both filtered and total-recoverable concentrations, the approach is to work from downstream to upstream to prevent stirring up Fe-rich colloidal material from the streambed. Inflow sites that were considered well mixed were sampled using grab techniques. Stream sites were sampled using equal-width integration techniques (Ward and Harr, 1990).

### 2.2.2. High-flow sampling

Diel changes in discharge are likely to occur during snowmelt runoff, and the assumption of steady conditions is not valid. To accommodate for the transient conditions, a sampling sequence must follow the changes within a parcel of water as it flows through the study reach, which is called a Lagrangian sampling scheme (Meade and Stevens, 2007; Moody, 1993). The schedule requires a precise timing of water movement along the study reach. To prepare a schedule for these variable conditions, a rhodamine WT dye tracer was added to the stream to observe its breakthrough at downstream sampling points. The dye was added in the morning, and the arrival time at the six downstream sites was determined using a portable fluorometer. Arrival times, calculated from the breakthrough curves, were used to schedule the synoptic sampling in the afternoon when snowmelt runoff would affect the stream. Under high-flow conditions, it was necessary to place stream sampling sites near bridges and at locations where it would be safe to wade the stream.

### 2.2.3. Colloidal concentrations and analytical methods

Transport of metals in mine-affected streams is influenced by Fe-rich colloids (Kimball et al., 1995). For the low-flow study colloidal concentrations of metals were calculated by subtracting the metal concentration of an ultrafiltered, acidified (10,000 Dalton pore size) sample from an unfiltered, acidified sample. The unfiltered, acidified sample represents a total recoverable concentration with respect to Al, Fe and metals associated with the Fe-rich colloids. The ultrafiltered sample is a better measure of a dissolved concentration than a 0.45-| m filtered sample for metals like Al, Cu, Fe, Pb and Zn that tend to be associated with the Fe-rich colloids. Colloidal particles that contain these metals can pass through a

Table 1
Description of synoptic sampling sites, Animas river, Colorado. Source: S, stream; RBI, right-bank inflow; LBI, left-bank inflow; Group, stream or inflow group assigned by cluster analysis.

| Down-stream distance, in meters | Source | Low flow | High flow | Description | Low-flow discharge, in L/s | High-flow discharge, in L/s | Stream or inflow group | pH, in standard units |
|---|---|---|---|---|---|---|---|---|
| 3655 | S | Yes | | Injection site and T0 upstream from injection | 620 | | 1 | 7.77 |
| 3909 | S | Yes | Yes | Downstream from injection at right bank stand of young spruce | 620 | 1461 | 1 | 7.88 |
| 4033 | RBI | Yes | Yes | Right-bank cascade from rocky bank | 1.00 | 39 | 1 | 8.32 |
| 4166 | S | Yes | Yes | Transport site T1 – upstream from Arastra Creek | 621 | 1500 | 1 | 8.10 |
| 4186 | LBI | Yes | Yes | Arastra Creek | 70.9 | | 1 | 8.05 |
| 4250 | S | Yes | Yes | Transport site T2 (high flow) – downstream from Arrastra Creek | 692 | 1515 | 2 | 7.95 |
| 4300 | RBI | Yes | | Small spring upstream from pipe bridge | | | 2 | 7.33 |
| 4353 | RBI | Yes | | Stream level spring | | | 3 | 4.48 |
| 4385 | RBI | | Yes | Moss and aluminum precipitation at spring | .75 | | | |
| 4473 | S | Yes | | Downstream from right bank acid inflows | 720 | | 2 | 7.91 |
| 4520 | RBI | Yes | | Additional spring on right bank | .10 | | 3 | 4.73 |
| 4533 | RBI | | Yes | Marshy ponds with algae near manganocrete | .75 | | | |
| 4544 | RBI | Yes | | Algal pond downstream from dry marsh | .10 | | 3 | 5.05 |
| 4581 | S | Yes | | Upstream from dry inflow draining left bank and old gravity mill | 721 | | 2 | 8.03 |
| 4586 | RBI | | Yes | Ponded water right bank; dripping from overnight bank | .75 | | | |
| 4713 | S | Yes | | Downstream from "Pinicle Gap" | 727 | | 2 | 7.99 |
| 4806 | S | Yes | | Upstream from acid inflows | 735 | | 2 | 7.74 |
| 4886 | RBI | | Yes | Seep with acid algae species | .75 | | | |
| 4916 | S | Yes | | Transport sites T2 (low flow)/T3 (high flow – downstream from acid inflows | 735 | 1558 | 2 | 7.83 |
| 4951 | RBI | Yes | Yes | Boulder Creek A62 | 31.4 | .90 | 1 | 8.07 |
| 5016 | S | Yes | | Downstream from Boulder Creek | 766 | | 2 | 7.90 |
| 5038 | RBI | Yes | Yes | Substantial orange precipitate in inflow | 4.05 | .04 | 4 | 6.14 |
| 5131 | S | Yes | | Downstream from orange precipitate tailings bin | 770 | | 2 | 7.79 |
| 5161 | LBI | Yes | | Pond next to stream on left bank | | | 2 | 7.02 |
| 5221 | LBI | Yes | Yes | Drainage from Aspen Mine | | .02 | 2 | 7.52 |
| 5251 | S | Yes | | Downstream from Aspen Mine inflow | 774 | | 2 | 7.84 |
| 5295 | LBI | Yes | | Drainage from left bank alteration | 6.13 | | 5 | 2.42 |
| 5306 | S | Yes | | Downstream from seeps on both sides | 781 | | 3 | 7.81 |
| 5356 | RBI | Yes | Yes | Discharge from slough draining tailings | 15.8 | .04 | 3 | 3.67 |
| 5448 | S | Yes | | Integrating right-bank inflow from slough | 796 | | 3 | 7.89 |
| 5536 | S | Yes | Yes | Transport site T4 – stream at Power Plant | 797 | 1649 | 3 | 7.89 |
| 5756 | S | Yes | | Upstream from right bank drainage ditch behind power plant | 798 | | 3 | 7.79 |
| 5858 | RBI | Yes | Yes | Seep along 60 m of grass | .95 | 0.00 | 2 | 6.19 |
| 5965 | S | Yes | | Small pool near stream | .24 | | 2 | 6.71 |
| 6038 | S | Yes | | Stream site for integration of seeps on both sides | 799 | | 3 | 7.78 |
| 6126 | S | Yes | | Upstream from substantial right bank staining | 799 | | 3 | 7.66 |
| 6131 | LBI | Yes | | At base of colluvium | | | 2 | 6.88 |
| 6150 | RBI | Yes | Yes | Red stained right bank discharge | | | 3 | 5.46 |
| 6265 | S | Yes | | Downstream from major right-bank inflow from tailings drainage | 800 | | 4 | 7.79 |
| 6465 | S | Yes | | Downstream from many right bank seeps | 801 | | 4 | 7.64 |
| 6745 | S | Yes | Yes | Transport site T5 – at Lacawana Bridge | 802 | 1701 | 4 | 7.56 |
| 6994 | S | Yes | | Upstream from Lacawana Mill | 803 | | 4 | 7.57 |
| 7049 | RBI | Yes | | New right-bank inflow | .78 | | 4 | 5.79 |
| 7177 | S | Yes | | Upstream from Lacawana discharge | 804 | | 4 | 7.41 |
| 7201 | LBI | Yes | | Discharge from Lacawana area, pond | .55 | | 1 | 7.95 |
| 7201 | RBI | | Yes | Drains right bank "protected" wetland area | | | | |
| 7306 | S | Yes | Yes | Transport site T6 – downstream from Lacawana Mill (Stakeholder site A66) | 804 | 1759 | | |
| 7585 | S | Yes | | Downstream from braids, good mixing | 805 | | 4 | 7.64 |
| 7750 | RBI | Yes | Yes | Ditch draining from pond nr roaster fines? | 1.17 | 805 | 4 | 5.97 |
| 7858 | S | Yes | Yes | Transport site T3 (low flow)/T7 (high flow) – at bridge with stream gage (Stakeholder site A68) | 807 | 1808 | 4 | 7.39 |

0.45-μm filter and be measured as dissolved metals when the colloids are dissolved by acidification (Kimball et al., 1992). Yet, aquatic standards for toxicity of several metals are legally based on 0.45-μm filtration. During the high-flow sampling, it was only possible to use ultrafiltration on a few samples, so the colloidal concentrations had to be calculated by subtracting the 0.45-μm filtered concentration from the unfiltered, acidified sample despite the possibility of bypassing the filter with colloids.

Concentrations of major-ion metals (Ca, Mg, Na, K, Al, Fe, Mn and Zn) from ultra-filtered, 0.45-μm filtered, and unfiltered sample treatments were determined by ICP-AES at the University of Southern Mississippi, Center for Trace Analysis. The remaining trace metal concentrations were determined using a ThermoFinnigan Element 2 sector field ICP-MS, also at the Center for Trace Analysis. Anion concentrations, including Br, were determined from 0.45-μm filtered, unacidified samples by using a Dionex DX-120 ion chromatograph at the USGS Utah Water Science Center (Brinton et al., 1995). Procedures for quality control for anion analyses are described in Kimball et al. (1999). Alkalinity was determined in the laboratory using an auto-titration system. Iron speciation was determined colorimeterically using a modification of the method of To et al. (1998).

### 2.3. Cluster analysis

An important objective of synoptic sampling is to recognize patterns or chemical characteristics that can be indicators of the various sources of metals in the catchment. Weathering of different mineral assemblages can impart distinct chemical signatures, and a particular signature may lead to identifying various sources of solutes. A method of cluster analysis called partitioning around medoids aids in distinguishing groups of samples (Kaufman and Rousseeuw, 1990). Using Euclidian distance in multivariate chemical space as a measure of similarity, each sample is then assigned to the cluster of the nearest medoid, which is a kind of multivariate median. Thus, cluster analysis provides an objective means of grouping samples in terms of the chemical distinctions. Choosing the number of groups, or medoids, for inflow or stream groups was guided by the ability to explain the chemical character of a group in terms of geologic, hydrologic, geographic, or geochemical information. Concentrations, in millimoles/L, were log-transformed for the analysis to emphasize mass-balance and logarithmic thermodynamic relationships among variables. The transformed data were also converted to standard normal variables before analysis. Only the filtered concentrations were used for inflow samples, but both filtered and colloidal concentrations of Al, Fe, Mn and Zn were used for stream samples. Changes in colloidal concentrations of stream samples often indicate important distinctions along the study reach (Kimball et al., 1995, 2003, 2009).

## 3. Results and discussion

Results of chemical determinations are presented in two tables, one for the spatial low- and high-flow synoptic sampling (Table S1, supplementary data), and the other for temporal data collected with auto-samplers (Table S2, supplementary data). Combining the discharge data with the chemical data provides the basis to quantify metal loads.

### 3.1. Discharge and the hydrologic context

Differences in the variation of Br concentration with time between the low- and high-flow experiments show the need for the two sampling designs. During low flow, the concentration of Br reached a relatively constant value for each site downstream from the injection, particularly during the period of synoptic sampling (Fig. 2A). In contrast, during the period of synoptic sampling for high flow, the increasing discharge from snowmelt runoff caused a decrease in Br concentration with time (Fig. 2B). The transient condition at high flow indicates the need for the Lagrangian scheme, and the relatively constant conditions at low flow justify the more typical downstream to upstream approach for low flow.

Calculation of discharge was based on dilution of the Br tracer along the study reach (Fig. 2C). Concentration of Br for both studies was very comparable because the injections each had a target of 1 mg/L Br at the end of the study reach. The comparable concentrations, however, represent substantially different values of discharge (Fig. 2D). The steady decrease of Br concentration along the study reach provides a clear indication of a net gaining reach of the Animas River. During both experiments, concentrations of Br in samples of inflow waters were near the lower limit of detection of Br except in a few samples that likely had some stream water mixed in (not shown in Fig. 2C, see Table S1).

During low flow, the greatest increase in discharge occurred from the inflow of Arrastra Creek and from several visible springs that enter between Arrastra Creek and 5448 m, downstream from the Aspen Mine inflow. From that point to the end of the study reach, the gain in discharge was much smaller, but was measurable. In contrast to low flow, at high flow the discharge profile clearly reflected the influence of inflow from snowmelt runoff (Fig. 2D). Similar to low-flow discharge, an increase in stream discharge occurred at Arrastra Creek, but that inflow accounted for a smaller percentage of the total increase during high flow. The most notable contrast between low- and high-flow discharge is the greater increase in discharge along the study reach during high flow. The increase occurred in each of the stream segments, but particularly downstream from T3, increasing from 1560 L/s at T3 to 1820 L/s at T7. During low flow, the increase from T3 to T7 was from 734 L/s to 806 L/s. The effect of the low-altitude runoff is the increase of 260 L/s compared to 72 L/s from T3 to T7. The goal of the 2003 study was to capture the early season snowmelt runoff from relatively low altitude parts of the upper Animas River Basin because that snowmelt drains many areas with metal sources. Had the goal been to capture peak flow from high-altitude snowmelt runoff, the study would have been conducted later in the spring. The highest average mean of monthly discharge generally occurs in June and is 14,320 L/s, compared to a mean of 1950 L/s for April (see http://waterdata.usgs.gov/co/nwis/). The Lagrangian method described here for sampling in April 2003 could be applied during periods of higher discharge.

Discharge at the end of the study reach during the low-flow experiment conducted in August 2002 was 806 L/s, only 36% of the flow measured during a previous experiment in 1997 (Paschke et al., 2005). August 2002 was a period of extreme low flow, the fourth year of drought in the Silverton area (Caffin and Druliner, 2007; Piechota et al., 2004). During this low flow, inflow sites were accessible for sampling that were submerged by the stream during the study in 1997.

### 3.2. Quantifying metal loading to the stream

Some of the most important information needed to make decisions about remediation of mine drainage is a basic understanding of the location, quantity, and chemical character of metal loading to a stream. Many studies have presented detailed chemical sampling as an approach to evaluate mine sites and to study biogeochemical processes. The present approach includes detailed sampling of stream and inflow chemistry but all within the context of catchment hydrology. Using this hydrologic context, it is possible to evaluate and compare locations of metal loading by using spatially detailed mass-loading profiles. The metal loading within

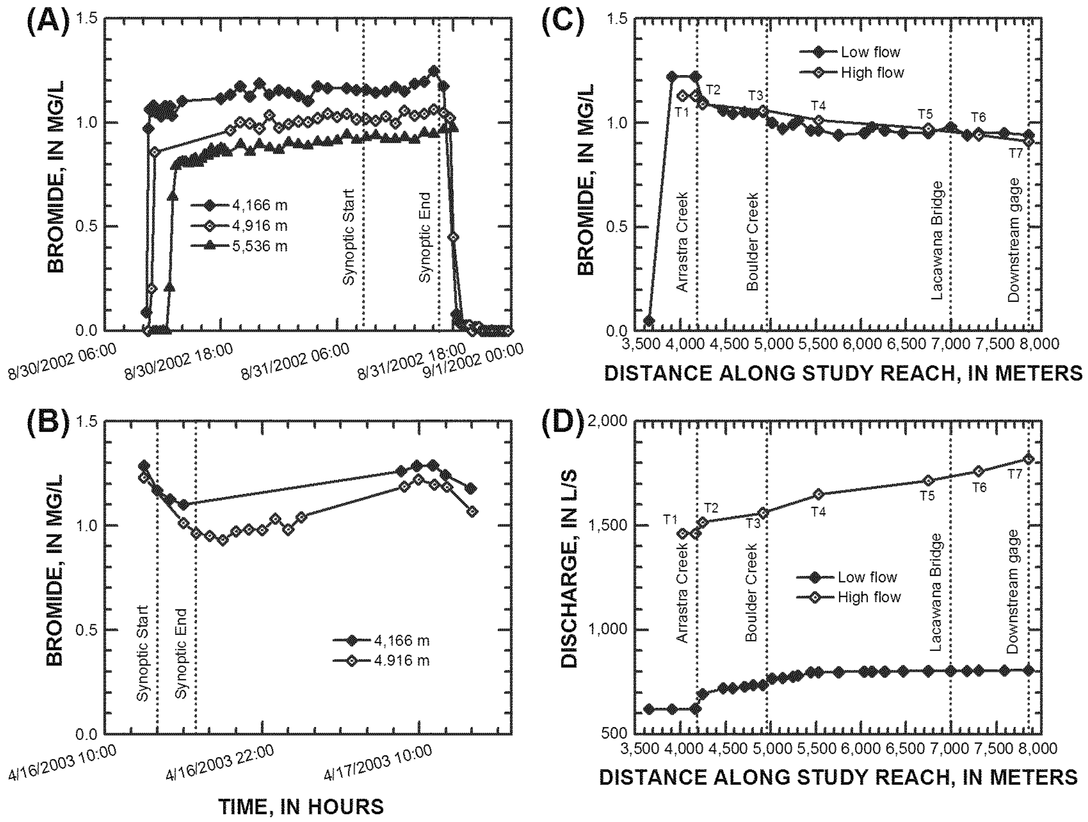


Fig. 2. Variation of Br$^{ffi}$ concentration with time (A) and (B), and variation of (C) Br$^{ffi}$ concentration and (D) calculated discharge with distance along the study reach for low flow in August 2002 and high flow in April 2003. The temporal view contrasts mostly constant conditions (A) with transient conditions (B). The spatial view shows the contribution to discharge from within the study reach during high flow.

a specific stream segment cannot always be matched to sources throughout the catchment. Topographic analysis (McGlynn and Seibert, 2003) tries to make that connection, but was not used in this study. This detailed mass-loading approach generally is used during low-flow conditions, as with the August 2002 study, when inflows to the stream, both from surface and ground water, are most likely to be detected.

### 3.2.1. Chemical character of inflow samples

Chemical compositions of inflow samples in a synoptic study provide a framework to understand the possible sources of loading and the influence of those sources on chemical changes in the stream. Typically, different source environments impart different aqueous chemical signatures to the water that drains them, and thus the relative contribution from different sources to a point in the stream can be inferred from the chemical character of water at that point in the stream. This was particularly true in August 2002 because of the extreme low-flow conditions. As noted, several inflows were available for sampling that had been covered by stream water during a synoptic sampling in 1997. Sampling during snowmelt runoff in 2003 did not provide the same level of detail for inflows because these inflows were covered at the higher stage of the river, and because inflows were diluted by mixing with snowmelt. Thus, information on the nature of inflows during high-flow conditions was inversely determined from quantifying in-stream chemical changes.

Jones (2007) details the mining, milling and production history of the Silverton area. Four mills operated at various times along the study reach. The Mayflower Mill was along the right bank, the Means-Wilfley Mill was near the stream, and the Silver Lake #2 Mill was along the left bank, all a short distance downstream from Arrastra Creek (Fig. 1). The William Crooke Mill was on the right bank, downstream from Boulder Creek, and the Lackawanna Mill was on the left bank. Tailings from each of these mills were located near the stream. The Mayflower tailings piles (Fig. 1) are the largest of these, partly because tailings and treatment waste from around the Silverton area have been added to those piles. Vincent and Elliott (2007), in discussing the distribution of mill tailings along the river upstream from the area in Fig. 1, indicate that the milling of ore at several locations resulted in the introduction of large volumes of fine-grained tailings into the fluvial system. With this wide-spread distribution of tailings, the application of cluster analysis to inflow samples can help infer meaningful patterns.

Cluster analysis of the synoptic inflow data from the low-flow sampling distinguished five groups of samples. The general chemical variation among these groups is indicated by representative samples for each group (Table 2). Characteristics of these groups reflect a continuum of interaction with mine waste, and present a complete range from “unaffected” (inflow group 1) to “most affected” (inflow group 4). Assignment to an inflow group does not imply a visual linkage of individual inflows to a particular tailings pile. Instead the linkage to “tailings and mine waste” is implied by the chemical character of individual inflows, and how the inflows are objectively assigned to a cluster. The distinctions along this continuum are as follows:

Group I – Unaffected: Samples with low metal and relatively low $SO_4$ concentrations; pH was basic.

Group II – Slightly affected: pH was lower than samples of inflow group 1 and metal concentrations were slightly higher. The concentration of $SO_4$ was almost five times greater than unaffected samples of inflow group I.

Table 2
Chemical composition of samples representing inflow groups determined by cluster analysis, Animas River, August 2002 [Group, Group from cluster analysis; N, number of samples in group; pH, in standard units; Base-metal sum, sum of cadmium, copper, lead, nickel, and zinc concentrations; Ca, calcium; Mg, magnesium; $SO_4$, sulfate; Alk, alkalinity as calcium carbonate; Al, aluminum; Cd, cadmium; Cu, copper; Fe, iron; Mn, manganese; Zn, zinc; all concentrations in milligrams per liter].

| Group | Extent of interaction with mine wastes | Representative sample | N | pH | Base-metal sum | Ca | Mg | $SO_4$ | Alk | Al | Cd | Cu | Fe | Mn | Zn |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | Unaffected | A3-4186 | 4 | 8.05 | 0.18 | 41.5 | 1.97 | 66.7 | 51.9 | 0.02 | 0.001 | 0.006 | 0.004 | 0.001 | 0.17 |
| II | Slightly affected | A3-6131 | 6 | 6.88 | 0.51 | 121 | 2.98 | 315 | 30.8 | .06 | .001 | .002 | .05 | .13 | .5 |
| III | Moderately affected | A3-7750 | 3 | 5.97 | 7.94 | 398 | 27.2 | 1217 | 14 | .61 | .041 | .045 | .27 | 75.1 | 7.82 |
| IV | Most affected | A3-4544 | 4 | 5.05 | 71 | 268 | 52.4 | 2179 | <.01 | 16.4 | .289 | .698 | .05 | 575 | 69.8 |
| V | Affected by alteration vein | A3-5295 | 1 | 2.42 | 4.29 | 59.8 | 13.1 | 1009 | <.01 | 37.2 | .692 | .692 | 163 | 7.28 | 2.95 |

Group III – Moderately affected: Yet a lower pH than inflow group II, and moderately high metal concentrations. Concentration of $SO_4$ was substantially greater than inflow group II.

Group IV – Most affected: Highest metal and $SO_4$ concentrations of any inflow group. The pH was the most acidic of all the groups except for the one sample of inflow group V.

Group V – Affected by alteration vein: A single sample with the lowest pH value, but only moderate metal and $SO_4$ concentrations. This combination results from substantial pyrite oxidation, but lack of ore minerals.

The distinctions suggested by these groups provide a range of inflow types that affect the chemical character of stream. The one sample affected by weathering of the alteration vein provides a contrast of impact from un-mined mineralization versus impact from mine waste, most notably because of its low pH at 2.42 but lower $SO_4$ than the inflows most affected by mine waste.

Three patterns of chemical variability among inflows further distinguish these groups and their impact on the Animas River along the study reach. First, the pattern of base metals with pH indicates the likely interaction with ore minerals in the mill tailings and mine waste (Fig. 3A). Those samples most affected by tailings and mine waste (group IV) have the highest base-metal concentrations (Table 2). Although the sample affected by an altered vein (group V) has the lowest pH, its sum of base-metal concentrations was substantially lower than in samples affected by tailings and mine waste (groups III and IV; Fig. 3A). Among the samples from inflow group IV, the sample with the lowest pH and base-metal sum (5356 m) was located near the altered vein outcrop (5295 m), and could have been a mixture between the types in inflow group IV and inflow group V (Table 2). Overall, this first pattern indicates the range in base-metal concentrations from unaffected to most affected inflows, and that stream sample compositions fall within the continuum.

The second pattern is illustrated by the strong logarithmic correlation between Cd and Zn concentrations (Fig. 3B). The nearly constant 1:1 logarithmic slope of Cd to Zn among inflow samples suggests the weathering of a relatively uniform composition of sphalerite from mill tailings, mine waste, and alteration vein. Samples from each of the inflow groups generally fall along this 1:1 line of order-of-magnitude increase. This pattern is consistent with the claim that the changes from unaffected inflows of group I to the most affected inflows of group IV represent a progressive extent of interaction with mining wastes.

A third pattern is illustrated by the influence of individual inflows with high Mn concentrations on the corresponding in-stream concentrations of Mn along the study reach (Fig. 4A). This Mn increase indicates the progressive downstream impact of drainage affected by mill tailings and mine waste on stream concentrations. Inflows near tailings and mine waste all had Mn concentrations higher than concentrations in the stream. One of the inflow samples from inflow group II (5858 m) also had a high Mn concentration and was likely affected by tailings and mine waste, even though other samples from group II did not have high Mn. The sample affected by the mineralized vein (inflow group V; 5295 m) had a relatively high Mn concentration, but not as high as the samples grouped into inflow group IV (Table 2). The relatively high Mn concentrations for group III, suggest that those inflows are also affected by tailings and mine waste, but, again, not to the extent as samples in group IV. None of these inflow groups, except the single sample from the altered vein (group V), was from a specific area along the study reach; as noted, the milling activities and the distribution of mill tailings was widespread along the study reach. Thus, the extent of interaction must be a result of the specific hydrologic interaction, or residence time of water interacting with many different deposits of tailings and mine waste. Consistent with these observations, Bove et al. (2009) have shown that the high F in samples of inflow waters along this reach is also an indication of the weathering of ore and gangue minerals in mill tailings and mine waste.

### 3.2.2. Chemical variation of the stream samples

The cumulative changes to chemistry along the river reflect the integrated influence of inflow chemistry. Independent influences of inflows are easier to define for low-flow conditions than for high-flow conditions. The chemical variation of stream water can also be classified using cluster analysis. However, clusters of stream groups usually represent sequential changes in both dissolved and some colloidal concentrations along the study reach. This characteristic of the analysis is useful for evaluating which inflows have the most impact on stream chemistry because changes in stream groups occur downstream from the most influential inflows. The change from one group of samples to the next is indicated by vertical divisions in Fig. 4. Each successive stream group had a higher dissolved Mn concentration, and the overall increase of dissolved Mn concentration was from about 0.2 mg/L to 1.4 mg/L at the end of the study reach.

Zinc concentration was notable because it increased in most stream segments along the entire study reach, and not just at the locations of specific inflows (Fig. 4B). This pattern suggests the widespread contribution of Zn from areas affected by hydrothermal alteration. Concentrations of Zn were not only high in samples of inflow group IV, but also in samples of inflow group III and the one sample from the alteration vein (inflow group V). Increases in concentrations of Fe (Fig. 4C), for example just downstream from 6150 m, were coincident with increases of Mn and Zn. The Mn to Zn mole ratio increased along the reach, particularly from 4250 m to 5448 m (represented by stream group II; Fig. 4D). This reach had substantial inflow of acidic springs along the right bank. The ratio increased more gradually, but consistently, along the rest of the study reach. In general, the samples from inflow groups 3 and 4 had the highest Mn to Zn mole ratio (Fig. 4D). The pattern of increasing Mn to Zn indicates the growing importance of water affected by weathering of tailings and mine waste along the study reach.

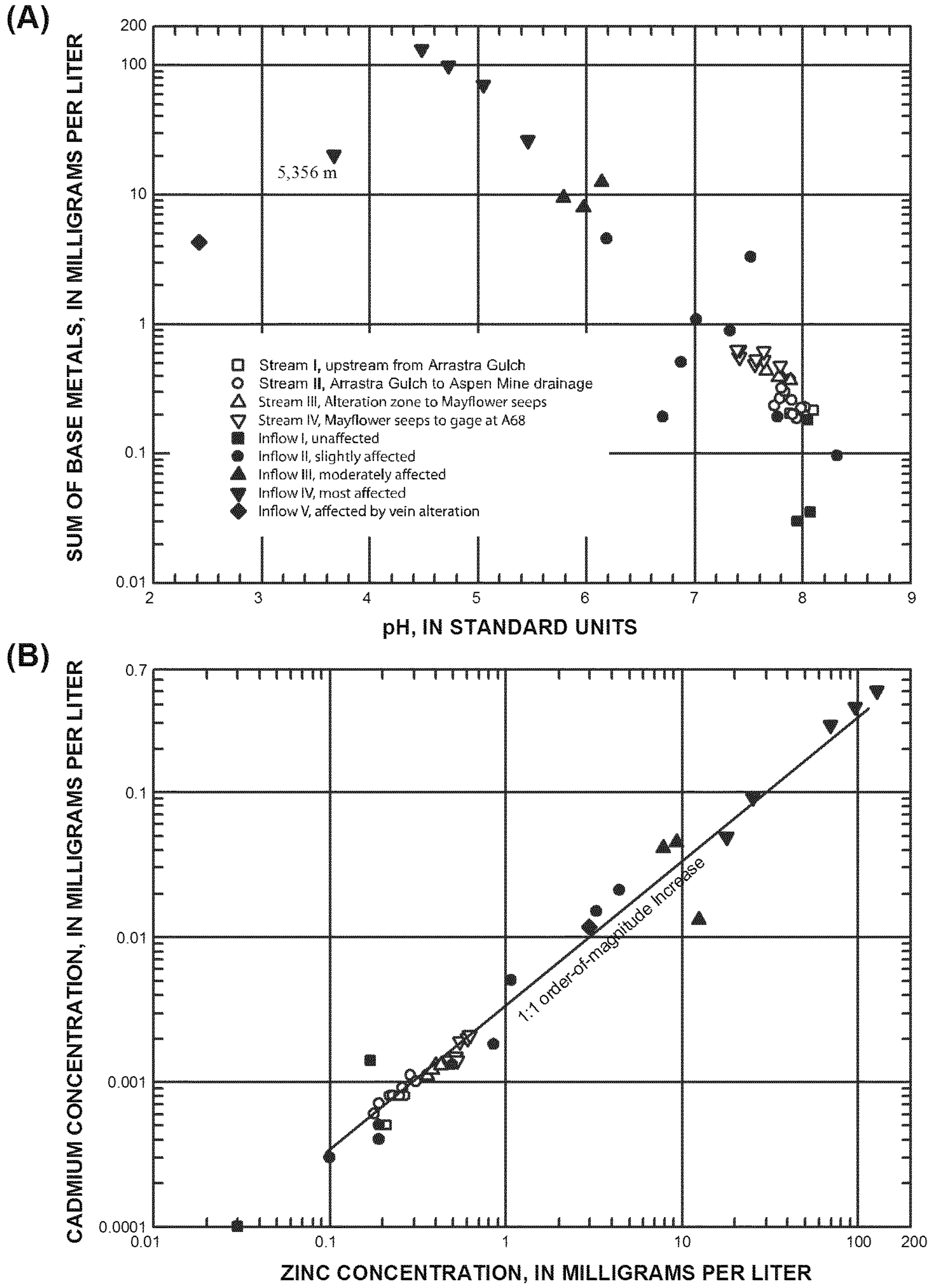


Fig. 3. Variation of (A) the sum of base-metal concentrations with pH and (B) Cd with Zn concentrations in stream and inflow samples, Animas River from Arrastra Creek to Silverton, August 2002. Legend in A also applies to B. Base metals and pH have been used as a Ficklin diagram (Plumlee et al., 1992) to classify mine drainage.

For stream samples, ultrafiltration allowed the distinction of more truly dissolved concentrations from colloidal concentrations (Kimball et al., 1992, 1995). Some of the differences among stream groups assigned by cluster analysis were the result of transformations between dissolved and colloidal concentrations. Iron principally occurred in the colloidal phase along the entire study reach (Fig. 4C), with the exception of one sample at 4916 m, obtained upstream from the inflow of Boulder Creek (4951 m). That sample may represent the cumulative effects of several acidic inflows along the left bank (Table 1), causing an increase in dissolved Fe. With the inflow of Boulder Creek, pH increased and colloidal Fe was again the dominant phase downstream. Low-flow concentration of colloidal Fe particularly increased downstream from the inflow at 6150 m, causing coloration of cobbles along the right bank downstream from the inflow and subsequent seeps.

Some of these patterns were also apparent in the high-flow sampling. The change in total Mn concentration at high flow followed the same pattern, but the increase in the final stream segment, from 7585 m to 7858 m, was substantially greater than during low-flow conditions. During high-flow, concentration of total Fe, which was again principally the colloidal concentration, was much higher, suggesting a flush of colloidal Fe by snowmelt runoff. This flush has been noted in other Animas River studies (Church et al., 1997). Higher concentrations of colloidal Fe are important because of their capacity to sorb toxic metals and affect their transport and storage downstream (Kimball et al., 1995; Runkel and Kimball, 2002; Schemel et al., 2000; Smith, 1999). The detailed sampling that is possible during low-flow conditions provided the highest resolution for characterization of metal sources.

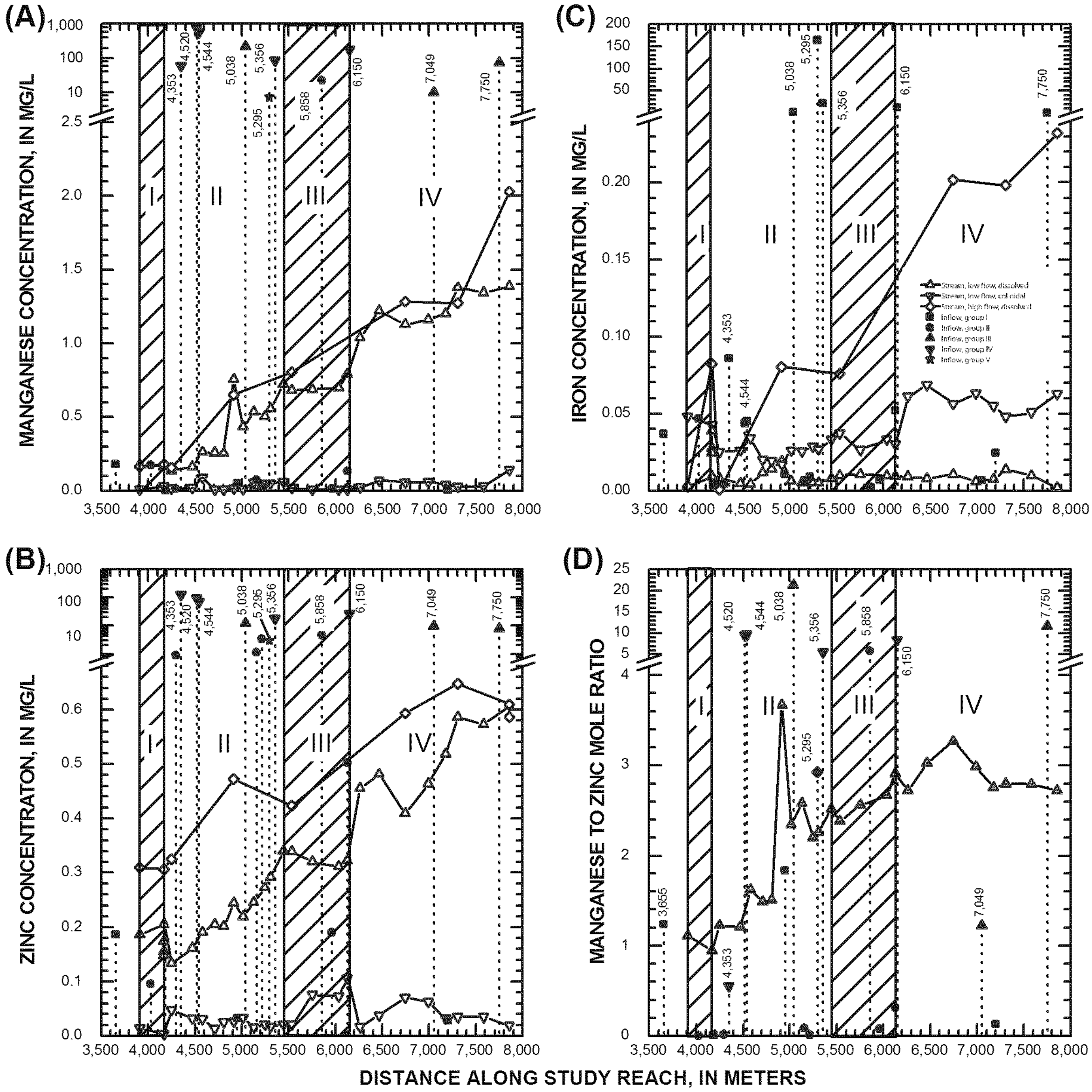


Fig. 4. Variation of dissolved, colloidal, and total (A) Mn, (B) Zn, (C) Fe concentrations, and (D) Mn to Zn mole ratio with distance along the study reach, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Legend in C also applies to A, B, and D. Roman numerals indicate reaches defined by cluster analysis of stream samples.

### 3.2.3. Locations of metal loading

Locations of metal loading are best understood within the context of inflow and stream chemistry. The detailed spatial sampling during low-flow conditions has provided information about metal sources and in-stream changes, as well as a detailed profile of stream discharge, allowing the calculation of a mass-loading profile for each of the measured constituents, both dissolved and colloidal. From that information, the profile of mass loading quantifies the relative contribution of the many sources in a catchment, enabling decisions based on the locations where relative masses from sources occur. A few profiles will be used here to indicate the locations of greatest loading during low- and high-flow conditions.

Individual solutes have substantially different absolute loads so a comparison among loading patterns is facilitated by using a normalized cumulative in-stream load. This normalization consists of dividing the sampled in-stream load at each stream site by the cumulative in-stream load at the end of the study reach (Kimball et al., 2002, 2003, 2007). The normalized load varies from 0 to 1, and individual increases represent a proportion of the total loading along the study reach. Three general patterns were indicated by normalized loading profiles of $SO_4$, Fe, Mn and Zn along the study reach (Fig. 5A). First, loading of $SO_4$ is unique among the solutes because 80% of the cumulative in-stream load during low flow comes from sources upstream from the study reach. This reflects the loading of $SO_4$ and metals from the oxidation of sulfide minerals upstream from the study reach. Much of that metal load, however, is subsequently removed through hydrolysis and precipitation of hydrous metal oxides, sorption onto surfaces, and other in-stream processes, leaving the $SO_4$ load to be transported downstream. Indeed, previous studies have indicated that substantial loading of Mn and Zn occurred upstream from the study reach, but these metal loads were not transported all the way downstream to the study reach (Kimball et al., 2007). This results in a second pattern of loading that was very different from that of $SO_4$ because most of the Mn load (Fig. 5A) at the end of the study reach was from sources along the study reach rather than from upstream sources (Kimball et al., 2007; Paschke et al., 2005). Within the study reach Mn loading had two very substantial increases, one from acidic

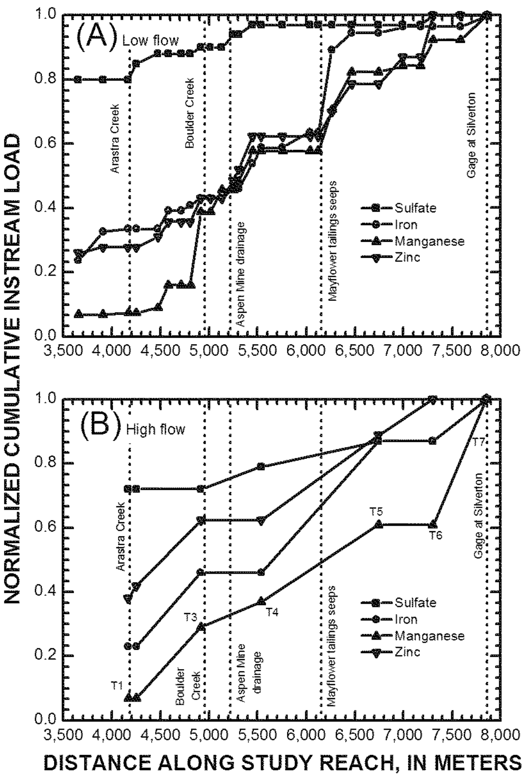


Fig. 5. Variation of normalized cumulative in-stream load of $SO_4^{2-}$, Fe, Mn and Zn during (A) August 2002, low-flow conditions and (B) April 2003, high-flow conditions with distance along the study reach, Animas River from Arrastra Creek to Silverton.

springs upstream from Boulder Creek (the stream segment from 4806 to 4916 m), and the other at the Mayflower tailings seeps (two segments from 6126 to 6465 m). Mine waste is stored at both locations. Third, patterns of Fe and Zn are similar to each other and their loading increased consistently along the entire study reach. About 25% of the Fe and Zn loads originated upstream from the study reach (Fig. 5A). Iron load increased much more than Zn load at the Mayflower tailings seeps (6150 m).

### 3.3. Quantifying seasonal changes between low- and high-flow conditions

Mass-loading information can also aid the decision making process by defining the magnitude of seasonal variation in metal loading. Such information is critical to the process of defining total maximum daily loads (TMDL). During low flow, detail is possible because of near steady conditions and greater accessibility to the stream. During high flow, transient conditions prevail, and much of the sampling effort must be used to describe temporal rather than spatial changes. As in this study, fewer stream and inflow sites may be accessible at high flow, and more emphasis must be placed on fewer stream sampling sites to understand the changing water quality and metal loading to the stream. These differences are illustrated here by comparing the low-flow data from August 2002 to the low-altitude snowmelt runoff in April 2003 (Fig. 5B). The low-altitude runoff, in the setting of the Animas River basin, has potential to affect metal loading because it drains mine wastes far enough away from the stream that they do not likely contribute metal loads to the stream during other times of the year, unless they contribute to groundwater feeding the stream.

Seasonal change between the low- and high-flow sampling is best indicated by the changes in load contribution of specific stream segments (Table 3). Normalized results are indicated in Fig. 5. For $SO_4$ load, the load entering the study reach from upstream was 5750 kg/day greater than during low flow (Table 3). In addition to that increased load, the contribution from low-altitude runoff along the study reach was 3180 kg/day. This substantial load increase was mostly contributed in the segments upstream from T4, T5, and T7 (Fig. 5; Table 3; see locations in Fig. 1). The seasonal change for Mn load was greater from sources along the study reach than it was for sources upstream from the study reach. The upstream contribution to Mn load only increased 10.8 kg/day during high flow, but along the study reach the Mn load increased 161 kg/day. This increase mostly came from the segments upstream from T3, T5, and T7 (Fig. 5B; Table 3). The most substantial of these increases came from the last stream segment from 7306 m to 7858 m; the load was 113 kg/day greater than that at low flow (Table 3). This runoff entered the stream through a ditch that drains an area with obvious mining wastes along the right bank near Silverton.

The increase in loading of Zn from upstream sources was 29 kg/day. This was nearly the same as the increase resulting from high flow along the study reach, which was 39 kg/day. If this loading came from Zn adsorbed to Fe-rich colloids, then these increases would resemble those for Fe load, but the increases are not similar (Table 3). No increase in Fe load occurred for the upstream contributions, but the increase due to high flow along the study reach was substantial, 29 kg/day. This increase mostly came from the segments upstream from T3 and T5. The segment upstream from T5 contains a very Fe-stained discharge from the right bank. The increase there could result from re-suspension of colloidal Fe that had been deposited on the streambed during low-flow conditions,

Table 3
Comparison of loading during low- and high-flow conditions (kg/day, kilograms per day; mg/L, milligrams per liter).

| | Sulfate | | Manganese | | Zinc | | Iron | | Copper | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Low | High | Low | High | Low | High | Low | High | Low | High |
| Start of reach (kg/day) | 6486 | 12,241 | 10.4 | 23.2 | 10.7 | 39.1 | 2.78 | 10.7 | 0.14 | 0.54 |
| End of reach (kg/day) | 8097 | 18,481 | 141 | 315 | 38.5 | 103 | 8.30 | 36.3 | .39 | 1.05 |
| Net gain (kg/day) | 1611 | 6240 | 131 | 292 | 27.8 | 55.5 | 5.52 | 25.6 | .26 | .51 |
| Concentration at T7 (mg/L) | 119 | 118 | 1.39 | 1.90 | .61 | .61 | .002 | .002 | .004 | .008 |
| Percent from reach | 20% | 28% | 93% | 93% | 72% | 62% | 67% | 70% | 65% | 80% |
| Percent from upstream | 80% | 72% | 72% | 72% | 28% | 38% | 33% | 30% | 35% | 20% |
| Change to T3 (kg/day) | 143 | 0 | 44.5 | 67.4 | 5.79 | 21.0 | .8 | 10.7 | .08 | .42 |
| Change to T4 (kg/day) | 646 | 1210 | 26.8 | 27.2 | 7.48 | 0 | 1.31 | 0 | .14 | .05 |
| Change to T5 (kg/day) | 0 | 1310 | 34.4 | 73.8 | 6.30 | 27.2 | 2.97 | 18.9 | 0 | 0 |
| Change to T6, kg/day | 203 | 0 | 14.4 | 0 | 8.22 | 11.4 | .16 | 0 | .03 | .10 |
| Change to T7 (kg/day) | 0 | 2260 | 10.9 | 124 | 0 | 0 | .29 | 6.07 | 0 | .31 |
| High flow increase from upstream (kg/day) | | 5750 | | 10.8 | | 29.1 | | <0 | | .41 |
| High flow increase within study reach (kg/day) | | 3180 | | 161 | | 38.9 | | 29.3 | | .63 |

from greater groundwater contribution from the Mayflower tailings piles during snowmelt, or from greater contributions from overland flow.

From low to high flow, the Cu load increased 0.41 kg/day from contributions upstream from the study area and 0.63 kg/day from contributions along the study reach (Table 3). Although these increases are of a lower magnitude than these other metals, they represent a substantial quantity of Cu entering the stream. The increase was mostly from the segments upstream from T3 and T7 (Table 3). Considering all these changes, the importance of the seasonal change is substantial, and this quantification of the changes can provide important information for making decisions by helping account for the temporal variation in loading that will affect TMDL allocations. The ability to account for loading during high flow helps to show that the increases in load along the study reach that come from specific stream segments, even though the spatial detail of the high-flow study is much less than that of the low-flow study.

The absolute values of load were substantially greater during high flow than during low flow, but the corresponding ultra-filtrate concentrations of these metals were almost equal during the two sampling periods (Fig. 4 and Table 3, using concentrations at T7). Because of the decrease in hardness resulting from dilution of Ca and Mg concentrations during high-flow conditions, the toxicity criteria are lower. Thus, even though loading during snowmelt runoff is substantially greater, the greater load does not necessarily result in concentrations that exceed the hardness-based toxicity criteria. This result comes from the use of ultrafiltration to define dissolved concentrations. Use of a 0.45-μm filter could obscure the finding by measuring colloidal material that passes through the filter (Kimball et al., 1992). Also the increase in Fe-rich colloidal material could result in toxic conditions, both chemically and physically.

Fey et al. (2002) found pre-snowmelt water to be more toxic to a species of amphipod and species of minnows than water that was half diluted by laboratory-prepared snowmelt runoff. As the amount of snowmelt-runoff water increased in their tests, the survival of these species increased. An important difference must be noted between the present toxicity calculations and that study. The toxicity reported in Fey et al. (2002) study included the impacts of drainage from Cement Creek and Mineral Creek, which are downstream from the sampling sites of this study, and likely have a substantial impact on their results (Kimball et al., 2007; Wright et al., 2007). They note that Cement Creek had the highest metal concentrations among the three converging streams for everything except Cu, which was highest in Mineral Creek, and Mn, which was highest in the upper Animas River.

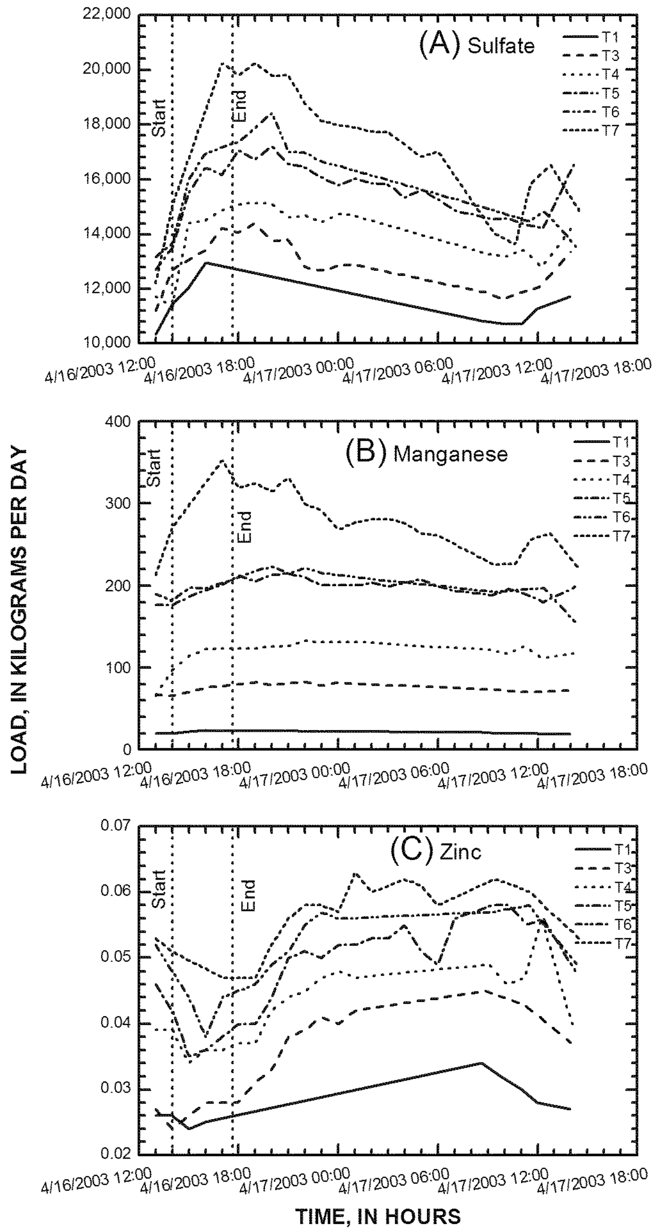


Fig. 6. Variation of (A) $SO_4^{2-}$, (B) Mn and (C) Zn loads with time, Animas River from Arrastra Creek to Silverton, April 2003. Vertical lines indicate the start and end of the high-flow synoptic sampling.

### 3.4. Quantifying diel variability during high flow

The April 2003 study included samples from six sites equipped with auto-samplers. These samples indicated temporal variability of sources along the study reach during the low-altitude snowmelt runoff and also changes resulting from biogeochemical processes over time (Fig. 6). Distinguishing between these two kinds of variation is facilitated by considering the changes in loads with time. Temporal variation in loads of $SO_4^{2-}$ (Fig. 6A) and Mn (Fig. 6B) both reflect variability in sources of loading to the stream, but their patterns indicate important differences. Loading of $SO_4^{2-}$ increased from site to site, and the magnitude of that increase varied with time. This clearly indicates the temporal effect of snowmelt runoff during the day, particularly for the segment between sites T6 and T7. The increase in $SO_4^{2-}$ load was greatest at site T7 during the period of runoff from 14:00 to 17:00 h on 16/4/03, and again between 10:38 and 12:45 on 17/4/03.

The increase of Mn load was apparent from site to site, particularly between sites T4 and T5. But unlike the increase of $SO_4^{2-}$ load, the temporal variation was minimal, except for the change between sites T6 and T7. The diel increase of both $SO_4^{2-}$ and Mn loads between sites T6 and T7 was the result of drainage from the inflow at 7750 m. This Mn loading pattern, in contrast to that of $SO_4^{2-}$, suggests that this temporal sampling represents constant sources that each increase the load downstream. This pattern is consistent with groundwater sources of Mn loading rather than snowmelt runoff (again, with the exception of the segment from T6 to T7). It is plausible that $SO_4^{2-}$ is more prone to diel variation than Mn because $SO_4^{2-}$ is more likely a part of soluble salts that might be washed into the stream. However, such salts would not be abundant in early spring. Distinctions between snowmelt flushing and groundwater contamination can be important in making decisions about remediation and achieving TMDL goals.

The temporally detailed sampling during the low-altitude snowmelt runoff provided data to evaluate biogeochemical processes that affect in-stream concentrations. Over the period of high-flow synoptic sampling, when snowmelt runoff occurred, Zn load decreased (Fig. 6C). This is in contrast to loads of $SO_4$ and Mn that increased (Fig 6A and B). Subsequently, from about 19:00 to 23:00 h on 4/16/03 Zn load increased. Because this is a pattern of loading rather than concentration, the decrease indicates either a reactive loss of Zn or a decreasing source of Zn, not a decrease through dilution. Because Zn load decreased while Mn and $SO_4$ loads increased, it is more likely that the decrease of Zn load was a result of reaction. Diel variation of Zn concentration in this stream was between 0.28 and 0.73 mg/L, more than doubling in concentration. A monitoring data set should account for this kind of diel variation.

The Zn pattern does not correspond to the Mn pattern that indicated dilution by the increase in snowmelt runoff. Sorption is the most likely reactive processes that could remove Zn from solution during the hours of synoptic sampling. Colloidal Fe load increased during the snowmelt runoff (note change in high-flow synoptic load, Fig. 5), and could have increased the likelihood of Zn sorption. This diel process for Zn in near-neutral waters has been documented in other streams affected by mine drainage during low-flow conditions (Gammons et al., 2005; Nimick et al., 2003, 2005). After the loading of Zn increased late in the day, it decreased during the morning hours the next day. This pattern indicates that Zn variation was independent from the dilution by snowmelt runoff. The timing of the diel increase in metals is consistent with the results of previous studies (Nimick et al., 2003). This temporal process should influence sampling designs for monitoring, as suggested by Nimick et al. (2003).

## 4. Conclusions

A mass-loading approach provides information that is helpful in making decisions about remediation of the effects of mine drainage. Having the right spatial information can support cost-effective decisions that may result in the greatest reduction in stream water contamination. Remediation decisions must be based on an understanding of the sources of metal loading, seasonal changes of loading, and reactive processes that affect loading. Field-scale experiments on the Animas River illustrate the spatially-detailed information that can support remediation decisions. Synoptic sampling during low-flow conditions provided a guide to the locations where metal loading occurred. A Lagrangian experiment during high-flow conditions indicated the significance of seasonal high-flow differences. Time-series chemical data indicated the importance of diel processes to guide the design of monitoring programs and the importance of quantifying diel temporal changes. Bringing all of this information together can be important in the planning and implementation of a TMDL process for streams affected by mine drainage.

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## Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.apgeochem.2010.02.005.

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Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

[Filter: UFA, ultrafiltration, FA, 0.45-micrometer, RA, total recoverable, FU, filtered untreated; Specific conductance, in microseimens per centimeter; CaCO3, calcium carbonate; ICP, inductively coupled plasma; mg/L, milligrams per literµg/L, micrograms per liter; blank cells, no analysis; LD, less than method detection limit; Sodium bromide was injected]

| Study | Sample identification | Source | Distance | Filter | Description | Date | Time | Specific conductance |
|---|---|---|---|---|---|---|---|---|
| | | | meters | | | | | |
| Low | A3-3655 | Stream | 3,655 | UFA | Injection site and T0 upstream from injection | 8/31/02 | 16:30 | 320 |
| Low | A3-3655 | Stream | 3,655 | FA | Injection site and T0 upstream from injection | 8/31/02 | 16:30 | 320 |
| Low | A3-3655 | Stream | 3,655 | RA | Injection site and T0 upstream from injection | 8/31/02 | 16:30 | 320 |
| Low | A3-4023 | Stream | 3,909 | UFA | Downstream from injection | 8/31/02 | 16:12 | 318 |
| Low | A3-4023 | Stream | 3,909 | FA | Downstream from injection | 8/31/02 | 16:12 | 318 |
| Low | A3-4023 | Stream | 3,909 | RA | Downstream from injection | 8/31/02 | 16:12 | 318 |
| Low | A3-4161 | Inflow | 4,033 | FA | right bank cascade from rocky bank (4033) | 8/31/02 | 16:30 | 323 |
| Low | A3-4161 | Inflow | 4,033 | RA | right bank cascade from rocky bank (4033) | 8/31/02 | 16:30 | 323 |
| Low | A3-4166 | Stream | 4,166 | UFA | T1 --> Upstream from Arrastra Creek | 8/31/02 | 15:50 | 329 |
| Low | A3-4166 | Stream | 4,166 | FA | T1 --> Upstream from Arrastra Creek | 8/31/02 | 15:50 | 329 |
| Low | A3-4166 | Stream | 4,166 | RA | T1 --> Upstream from Arrastra Creek | 8/31/02 | 15:50 | 329 |
| Low | A3-4186 | Inflow | 4,186 | UFA | Arrastra Creek | 8/31/02 | 15:51 | 239 |
| Low | A3-4186 | Inflow | 4,186 | FA | Arrastra Creek | 8/31/02 | 15:51 | 239 |
| Low | A3-4186 | Inflow | 4,186 | RA | Arrastra Creek | 8/31/02 | 15:51 | 239 |
| Low | A3-4250A | Stream | 4,250 | UFA | Downstream from Arrastra Creek | 8/31/02 | 15:33 | 316 |
| Low | A3-4250A | Stream | 4,250 | FA | Downstream from Arrastra Creek | 8/31/02 | 15:33 | 316 |
| Low | A3-4250A | Stream | 4,250 | RA | Downstream from Arrastra Creek | 8/31/02 | 15:33 | 316 |
| Low | A3-4250B | Stream | 4,250 | UFA | Downstream from Arrastra Creek | 8/31/02 | 15:38 | 315 |
| Low | A3-4250B | Stream | 4,250 | FA | Downstream from Arrastra Creek | 8/31/02 | 15:38 | 315 |
| Low | A3-4250B | Stream | 4,250 | RA | Downstream from Arrastra Creek | 8/31/02 | 15:38 | 315 |
| Low | A3-4300 | Inflow | 4,300 | FA | Small spring upstream from pipe bridge | 8/30/02 | 13:34 | 611 |
| Low | A3-4353 | Inflow | 4,353 | FA | Stream level spring | 8/30/02 | 13:47 | 1,662 |
| Low | A3-4385 | Inflow | 4,385 | FU | Moss and aluminum precipitation at spring | 8/30/02 | 14:05 | 1,602 |
| Low | A3-4473 | Stream | 4,473 | UFA | Downstream from right bank acid inflows | 8/31/02 | 15:20 | 313 |
| Low | A3-4473 | Stream | 4,473 | FA | Downstream from right bank acid inflows | 8/31/02 | 15:20 | 313 |
| Low | A3-4473 | Stream | 4,473 | RA | Downstream from right bank acid inflows | 8/31/02 | 15:20 | 313 |
| Low | A3-4520 | Inflow | 4,520 | FA | Additional spring on right bank | 8/30/02 | 14:35 | 3,310 |
| Low | A3-4544 | Inflow | 4,544 | FA | Algal pond downstream from dry marsh | 8/30/02 | 14:25 | 2,500 |
| Low | A3-4581 | Stream | 4,581 | UFA | Upstream from dry inflow draining left bank and old gravity mill | 8/31/02 | 15:05 | 312 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Description | Date | Time | Specific conductance |
|---|---|---|---|---|---|---|---|---|
| | | | meters | | | | | |
| Low | A3-4581 | Stream | 4,581 | FA | Upstream from dry inflow draining left bank and old gravity mill | 8/31/02 | 15:05 | 312 |
| Low | A3-4581 | Stream | 4,581 | RA | Upstream from dry inflow draining left bank and old gravity mill | 8/31/02 | 15:05 | 312 |
| Low | A3-4713 | Stream | 4,713 | UFA | Downstream from "Pinicle Gap" | 8/31/02 | 14:52 | 311 |
| Low | A3-4713 | Stream | 4,713 | FA | Downstream from "Pinicle Gap" | 8/31/02 | 14:52 | 311 |
| Low | A3-4713 | Stream | 4,713 | RA | Downstream from "Pinicle Gap" | 8/31/02 | 14:52 | 311 |
| Low | A3-4806 | Stream | 4,806 | UFA | Upstream from Acid inflows | 8/31/02 | 14:25 | 313 |
| Low | A3-4806 | Stream | 4,806 | FA | Upstream from Acid inflows | 8/31/02 | 14:25 | 313 |
| Low | A3-4806 | Stream | 4,806 | RA | Upstream from Acid inflows | 8/31/02 | 14:25 | 313 |
| Low | A3-4886 | Inflow | 4,886 | FU | Seep w/ acid algae | 8/30/02 | 15:00 | 2,450 |
| Low | A3-4916A | Stream | 4,916 | FU | T2 --> Downstream from acid inflows, upstream from Boulder Creek | 8/31/02 | 14:10 | 320 |
| Low | A3-4916B | Stream | 4,916 | UFA | T2 --> Downstream from acid inflows, upstream from Boulder Creek | 8/31/02 | 14:17 | 329 |
| Low | A3-4916B | Stream | 4,916 | FA | T2 --> Downstream from acid inflows, upstream from Boulder Creek | 8/31/02 | 14:17 | 329 |
| Low | A3-4916B | Stream | 4,916 | RA | T2 --> Downstream from acid inflows, upstream from Boulder Creek | 8/31/02 | 14:17 | 329 |
| Low | A3-4951 | Inflow | 4,951 | FA | Boulder Creek A62 | 8/31/02 | 14:04 | 171 |
| Low | A3-4951 | Inflow | 4,951 | RA | Boulder Creek A62 | 8/31/02 | 14:04 | 171 |
| Low | A3-5016 | Stream | 5,016 | UFA | Downstream from Boulder Creek | 8/31/02 | 13:58 | 310 |
| Low | A3-5016 | Stream | 5,016 | FA | Downstream from Boulder Creek | 8/31/02 | 13:58 | 310 |
| Low | A3-5016 | Stream | 5,016 | RA | Downstream from Boulder Creek | 8/31/02 | 13:58 | 310 |
| Low | A3-5038 | Inflow | 5,038 | UFA | Substantial orange ppt inflow | 8/31/02 | 13:54 | 2,380 |
| Low | A3-5038 | Inflow | 5,038 | FA | Substantial orange ppt inflow | 8/31/02 | 13:54 | 2,380 |
| Low | A3-5038 | Inflow | 5,038 | RA | Substantial orange ppt inflow | 8/31/02 | 13:54 | 2,380 |
| Low | A3-5131 | Stream | 5,131 | UFA | Downstream from orange ppt tailings bin | 8/31/02 | 13:45 | 318 |
| Low | A3-5131 | Stream | 5,131 | FA | Downstream from orange ppt tailings bin | 8/31/02 | 13:45 | 318 |
| Low | A3-5131 | Stream | 5,131 | RA | Downstream from orange ppt tailings bin | 8/31/02 | 13:45 | 318 |
| Low | A3-5161 | Inflow | 5,161 | FA | Pond to stream left bank with fish | 8/31/02 | 13:40 | 936 |
| Low | A3-5221 | Inflow | 5,221 | FA | Drainage from Aspen Mine (not Blair Gulch) | 8/31/02 | 13:35 | 914 |
| Low | A3-5251 | Stream | 5,251 | UFA | Downstream from Aspen Mine; upstream from seepage inflows | 8/31/02 | 13:25 | 321 |
| Low | A3-5251 | Stream | 5,251 | FA | Downstream from Aspen Mine; upstream from seepage inflows | 8/31/02 | 13:25 | 321 |
| Low | A3-5251 | Stream | 5,251 | RA | Downstream from Aspen Mine; upstream from seepage inflows | 8/31/02 | 13:25 | 321 |
| Low | A3-5269 | Inflow | 5,269 | FU | Beginning of right bank algal seeps | 8/30/02 | 15:20 | 1,289 |
| Low | A3-5295 | Inflow | 5,295 | FA | Drainage from left bank alteration | 8/30/02 | 15:28 | 1,897 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Description | Date | Time | Specific conductance |
|---|---|---|---|---|---|---|---|---|
| | | | meters | | | | | |
| Low | A3-5306 | Stream | 5,306 | UFA | Downstream from seeps on both sides | 8/31/02 | 13:16 | 313 |
| Low | A3-5306 | Stream | 5,306 | FA | Downstream from seeps on both sides | 8/31/02 | 13:16 | 313 |
| Low | A3-5306 | Stream | 5,306 | RA | Downstream from seeps on both sides | 8/31/02 | 13:16 | 313 |
| Low | A3-5356 | Inflow | 5,356 | UFA | Discharge from slough draining tailings | 8/31/02 | 12:48 | 1,728 |
| Low | A3-5356 | Inflow | 5,356 | FA | Discharge from slough draining tailings | 8/31/02 | 12:48 | 1,728 |
| Low | A3-5356 | Inflow | 5,356 | RA | Discharge from slough draining tailings | 8/31/02 | 12:48 | 1,728 |
| Low | A3-5448 | Stream | 5,448 | UFA | Integrating right bank inflow from slough | 8/31/02 | 12:35 | 315 |
| Low | A3-5448 | Stream | 5,448 | FA | Integrating right bank inflow from slough | 8/31/02 | 12:35 | 315 |
| Low | A3-5448 | Stream | 5,448 | RA | Integrating right bank inflow from slough | 8/31/02 | 12:35 | 315 |
| Low | A3-5536 | Stream | 5,536 | UFA | Stream at Power Plant | 8/31/02 | 12:20 | 314 |
| Low | A3-5536 | Stream | 5,536 | FA | Stream at Power Plant | 8/31/02 | 12:20 | 314 |
| Low | A3-5536 | Stream | 5,536 | RA | Stream at Power Plant | 8/31/02 | 12:20 | 314 |
| Low | A3-5756 | Stream | 5,756 | UFA | Upstream from right bank drainage ditch behind power plant | 8/31/02 | 12:02 | 324 |
| Low | A3-5756 | Stream | 5,756 | FA | Upstream from right bank drainage ditch behind power plant | 8/31/02 | 12:02 | 324 |
| Low | A3-5756 | Stream | 5,756 | RA | Upstream from right bank drainage ditch behind power plant | 8/31/02 | 12:02 | 324 |
| Low | A3-5815 | Inflow | 5,815 | FU | Draining from fern and moss | 8/30/02 | 16:32 | 458 |
| Low | A3-5858 | Inflow | 5,858 | FA | Seep along 60 m of grass | 8/30/02 | 16:50 | 661 |
| Low | A3-5965 | Inflow | 5,965 | FA | Small pool near stream | 8/30/02 | 16:17 | 542 |
| Low | A3-6038 | Stream | 6,038 | UFA | Old T5--Integration of seeps on both sides | 8/31/02 | 11:42 | 319 |
| Low | A3-6038 | Stream | 6,038 | FA | Old T5--Integration of seeps on both sides | 8/31/02 | 11:42 | 319 |
| Low | A3-6038 | Stream | 6,038 | RA | Old T5--Integration of seeps on both sides | 8/31/02 | 11:42 | 319 |
| Low | A3-6126 | Stream | 6,126 | UFA | Upstream from substantial right bank staining | 8/31/02 | 11:26 | 321 |
| Low | A3-6126 | Stream | 6,126 | FA | Upstream from substantial right bank staining | 8/31/02 | 11:26 | 321 |
| Low | A3-6126 | Stream | 6,126 | RA | Upstream from substantial right bank staining | 8/31/02 | 11:26 | 321 |
| Low | A3-6131 | Inflow | 6,131 | FA | At base of colluvium | 8/31/02 | 11:17 | 638 |
| Low | A3-6131 | Inflow | 6,131 | RA | At base of colluvium | 8/31/02 | 11:17 | 638 |
| Low | A3-6150 | Inflow | 6,150 | UFA | Red stained right bank discharge | 8/31/02 | 11:11 | 1,554 |
| Low | A3-6150 | Inflow | 6,150 | FA | Red stained right bank discharge | 8/31/02 | 11:11 | 1,554 |
| Low | A3-6150 | Inflow | 6,150 | RA | Red stained right bank discharge | 8/31/02 | 11:11 | 1,554 |
| Low | A3-6265 | Stream | 6,265 | UFA | downstream from major right bank inflow from tailings drainage | 8/31/02 | 10:53 | 333 |
| Low | A3-6265 | Stream | 6,265 | FA | Downstream from major right bank inflow from tailings drainage | 8/31/02 | 10:53 | 333 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Description | Date | Time | Specific conductance |
|---|---|---|---|---|---|---|---|---|
| | | | meters | | | | | |
| Low | A3-6265 | Stream | 6,265 | RA | Downstream from major right bank inflow from tailings drainage | 8/31/02 | 10:53 | 333 |
| Low | A3-6465 | Stream | 6,465 | UFA | Downstream from many right bank seeps | 8/31/02 | 10:36 | 300 |
| Low | A3-6465 | Stream | 6,465 | FA | Downstream from many right bank seeps | 8/31/02 | 10:36 | 300 |
| Low | A3-6465 | Stream | 6,465 | RA | Downstream from many right bank seeps | 8/31/02 | 10:36 | 300 |
| Low | A3-6745 | Stream | 6,745 | UFA | At Lacawana Bridge | 8/31/02 | 10:11 | 338 |
| Low | A3-6745 | Stream | 6,745 | FA | At Lacawana Bridge | 8/31/02 | 10:11 | 338 |
| Low | A3-6745 | Stream | 6,745 | RA | At Lacawana Bridge | 8/31/02 | 10:11 | 338 |
| Low | A3-6994 | Stream | 6,994 | UFA | Upstream from Lacawana Mill | 8/31/02 | 10:02 | 335 |
| Low | A3-6994 | Stream | 6,994 | FA | Upstream from Lacawana Mill | 8/31/02 | 10:02 | 335 |
| Low | A3-6994 | Stream | 6,994 | RA | Upstream from Lacawana Mill | 8/31/02 | 10:02 | 335 |
| Low | A3-7049 | Inflow | 7,049 | FA | New left bank inflow | 8/31/02 | 9:54 | 797 |
| Low | A3-7177 | Stream | 7,177 | UFA | Upstream from Lacawana discharge | 8/31/02 | 9:36 | 322 |
| Low | A3-7177 | Stream | 7,177 | FA | Upstream from Lacawana discharge | 8/31/02 | 9:36 | 322 |
| Low | A3-7177 | Stream | 7,177 | RA | Upstream from Lacawana discharge | 8/31/02 | 9:36 | 322 |
| Low | A3-7201 | Inflow | 7,201 | FA | Discharge from Lacawana area, pond | 8/31/02 | 9:28 | 294 |
| Low | A3-7201 | Inflow | 7,201 | RA | Discharge from Lacawana area, pond | 8/31/02 | 9:28 | 294 |
| Low | A3-7306 | Stream | 7,306 | UFA | Downstream from Lacawana Mill (A66) | 8/31/02 | 9:15 | 335 |
| Low | A3-7306 | Stream | 7,306 | FA | Downstream from Lacawana Mill (A66) | 8/31/02 | 9:15 | 335 |
| Low | A3-7306 | Stream | 7,306 | RA | Downstream from Lacawana Mill (A66) | 8/31/02 | 9:15 | 335 |
| Low | A3-7585 | Stream | 7,585 | UFA | Downstream from braids, good mixing | 8/31/02 | 9:02 | 336 |
| Low | A3-7585 | Stream | 7,585 | FA | Downstream from braids, good mixing | 8/31/02 | 9:02 | 336 |
| Low | A3-7585 | Stream | 7,585 | RA | Downstream from braids, good mixing | 8/31/02 | 9:02 | 336 |
| Low | A3-7750 | Inflow | 7,750 | UFA | Ditch draining from pond nr roaster fines? | 8/31/02 | 8:55 | 1,801 |
| Low | A3-7750 | Inflow | 7,750 | FA | Ditch draining from pond nr roaster fines? | 8/31/02 | 8:55 | 1,801 |
| Low | A3-7750 | Inflow | 7,750 | RA | Ditch draining from pond nr roaster fines? | 8/31/02 | 8:55 | 1,801 |
| Low | A3-7858 | Stream | 7,858 | UFA | T3--At bridge / gage A68 | 8/31/02 | 8:45 | 331 |
| Low | A3-7858 | Stream | 7,858 | FA | T3--At bridge / gage A68 | 8/31/02 | 8:45 | 331 |
| Low | A3-7858 | Stream | 7,858 | RA | T3--At bridge / gage A68 | 8/31/02 | 8:45 | 331 |
| High | A3HF-4023 | Stream | 3,909 | FU | Upstream 10 m from cascading right bank inflow | 4/16/03 | 14:55 | 256 |
| High | A3HF-4161 | Inflow | 4,033 | FU | Right bank cascade from rocky bank (4033) | 4/16/03 | 14:00 | 103 |
| High | A3HF-4166 | Stream | 4,166 | FU | T1 --> Upstream from Arrastra | 4/16/03 | 15:05 | 271 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Description | Date | Time | Specific conductance |
|---|---|---|---|---|---|---|---|---|
| | | | meters | | | | | |
| High | A3HF-4186 | Inflow | 4,186 | FU | Arastra Gulch | 4/16/03 | 15:03 | 117 |
| High | A3HF-4250 | Stream | 4,250 | FU | T2 --> Downstream from bend Downstream from Arastra Gulch | 4/16/03 | 15:08 | 157 |
| High | A3HF-4385 | Inflow | 4,385 | FU | Moss and Al pptn at spring | 4/16/03 | 14:42 | 1,710 |
| High | A3HF-WP142 | Inflow | 4,533 | FU | Marshy ponds with algae near manganocrete | 4/16/03 | 15:25 | 4,090 |
| High | A3HF-4580 | Inflow | 4,586 | FU | Dripping from moss after draining ponds | 4/16/03 | 15:15 | 1,492 |
| High | A3HF-4892 | Inflow | 4,886 | FU | Largest channel of several coming in | 4/16/03 | 16:10 | 1,586 |
| High | A3HF-4916 | Stream | 4,916 | FU | T3 --> Downstream from acid inflows, Upstream from Boulder Creek | 4/16/03 | 15:30 | 239 |
| High | A3HF-4951 | Inflow | 4,951 | FU | Boulder Creek A62 | 4/16/03 | 15:40 | 12 |
| High | A3HF-5038 | Inflow | 5,038 | FU | Substantial orange ppt inflow | 4/16/03 | 16:00 | 1,760 |
| High | A3HF-5221 | Inflow | 5,221 | FU | Drainage from Aspen Mine | 4/16/03 | 15:53 | 838 |
| High | A3HF-5356 | Inflow | 5,356 | FU | Discharge from slough draining tailings | 4/16/03 | 16:40 | 2,510 |
| High | A3HF-5536 | Stream | 5,536 | FU | T4 --> Stream at Power Plant | 4/16/03 | 15:45 | 115 |
| High | A3HF-5855 | Inflow | 5,858 | FU | Ditch draining from power plant | 4/16/03 | 16:28 | 191 |
| High | A3HF-6150 | Inflow | 6,150 | FU | Red stained right bank discharge | 4/16/03 | 17:10 | 2,160 |
| High | A3HF-6745 | Stream | 6,745 | FU | T5 --> At Lacawana Bridge | 4/16/03 | 16:20 | 173 |
| High | A3HF-7100 | Inflow | 7,201 | FU | Drains right bank "protected" wetland area | 4/16/03 | 17:22 | 30 |
| High | A3HF-7306 | Stream | 7,306 | FU | T6 --> Downstream from Lacawana Mill (A66) | 4/16/03 | 16:35 | 71 |
| High | A3HF-7750 | Inflow | 7,750 | FU | Ditch draining from pond nr roaster fines? | 4/16/03 | 17:38 | 1,081 |
| High | A3HF-7858A | Stream | 7,858 | FU | T7--> At bridge / gage A68 | 4/16/03 | 16:50 | 133 |
| High | A3HF-7858B | Stream | 7,858 | FU | T7--> At bridge / gage A68 | 4/16/03 | 16:55 | 195 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

[Filter: UFA, ultrafiltration, FA, 0.45-micrometer, RA, total rec
coupled plasma; mg/L, milligrams per literµg/L, micrograms p

| Study | Sample identification | Source | Distance | Filter | pH | Temperature | Calcium | Magnesium | Sodium | Potassium | Alkalinity | Sulfate | Sulfate ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | | Celcius | mg/L | mg/L | mg/L | mg/L | mg/L as CaCO3 | mg/L | mg/L |
| Low | A3-3655 | Stream | 3,655 | UFA | 7.77 | 15.5 | 49.0 | 3.02 | 2.14 | .65 | 30.22 | 121 | 110 |
| Low | A3-3655 | Stream | 3,655 | FA | 7.77 | 15.5 | 52.5 | 3.21 | 2.29 | .70 | 30.22 | 121 | 116 |
| Low | A3-3655 | Stream | 3,655 | RA | 7.77 | 15.5 | 50.4 | 3.09 | 2.13 | .68 | 30.22 | 121 | 112 |
| Low | A3-4023 | Stream | 3,909 | UFA | 7.88 | 15.5 | 49.5 | 2.99 | 2.44 | .64 | 30.97 | 121 | 107 |
| Low | A3-4023 | Stream | 3,909 | FA | 7.88 | 15.5 | 51.1 | 3.21 | 2.56 | .67 | 30.97 | 121 | 115 |
| Low | A3-4023 | Stream | 3,909 | RA | 7.88 | 15.5 | 56.5 | 3.22 | 2.55 | .72 | 30.97 | 121 | |
| Low | A3-4161 | Inflow | 4,033 | FA | 8.32 | 9.0 | 52.7 | 3.28 | 3.40 | .43 | 74.72 | 78.5 | 73.25 |
| Low | A3-4161 | Inflow | 4,033 | RA | 8.32 | 9.0 | 58.4 | 3.63 | 3.51 | .48 | 74.72 | 78.5 | |
| Low | A3-4166 | Stream | 4,166 | UFA | 8.10 | 15.5 | 50.5 | 3.13 | 2.60 | .74 | 28.96 | 121 | 121 |
| Low | A3-4166 | Stream | 4,166 | FA | 8.10 | 15.5 | 50.0 | 3.06 | 2.51 | .61 | 28.96 | 121 | 109 |
| Low | A3-4166 | Stream | 4,166 | RA | 8.10 | 15.5 | 57.0 | 3.25 | 2.58 | .70 | 28.96 | 121 | |
| Low | A3-4186 | Inflow | 4,186 | UFA | 8.05 | 9.5 | 38.0 | 1.92 | 2.37 | .54 | 51.85 | 63.2 | 59.23 |
| Low | A3-4186 | Inflow | 4,186 | FA | 8.05 | 9.5 | 39.8 | 1.96 | 2.39 | .54 | 51.85 | 63.2 | 60.16 |
| Low | A3-4186 | Inflow | 4,186 | RA | 8.05 | 9.5 | 41.5 | 1.97 | 2.27 | .55 | 51.85 | 63.2 | |
| Low | A3-4250A | Stream | 4,250 | UFA | 8.01 | 14.5 | 47.7 | 2.94 | 2.44 | .69 | 32.03 | 115 | 107 |
| Low | A3-4250A | Stream | 4,250 | FA | 8.01 | 14.5 | 51.5 | 3.13 | 2.63 | .68 | 32.03 | 115 | 112 |
| Low | A3-4250A | Stream | 4,250 | RA | 8.01 | 14.5 | 52.2 | 3.05 | 2.40 | .67 | 32.03 | 115 | |
| Low | A3-4250B | Stream | 4,250 | UFA | 7.89 | 14.5 | 49.9 | 2.97 | 2.47 | .71 | 35.32 | 114 | 108 |
| Low | A3-4250B | Stream | 4,250 | FA | 7.89 | 14.5 | 50.8 | 3.00 | 2.53 | .64 | 35.32 | 114 | 107 |
| Low | A3-4250B | Stream | 4,250 | RA | 7.89 | 14.5 | 49.5 | 3.01 | 2.48 | .66 | 35.32 | 114 | 109 |
| Low | A3-4300 | Inflow | 4,300 | FA | 7.33 | 8.5 | 106 | 8.56 | 4.79 | 1.05 | 35.01 | 265 | 240 |
| Low | A3-4353 | Inflow | 4,353 | FA | 4.48 | 20.5 | 206 | 37.8 | 6.97 | 2.99 | < .01 | 1,110 | 894 |
| Low | A3-4385 | Inflow | 4,385 | FU | 4.69 | 15.0 | | | | | < .01 | 1,000 | |
| Low | A3-4473 | Stream | 4,473 | UFA | 7.91 | 15.0 | 48.0 | 3.05 | 2.46 | .64 | 32.47 | 114 | 106 |
| Low | A3-4473 | Stream | 4,473 | FA | 7.91 | 15.0 | 49.2 | 3.03 | 2.55 | .65 | 32.47 | 114 | 104 |
| Low | A3-4473 | Stream | 4,473 | RA | 7.91 | 15.0 | 52.8 | 2.94 | 2.35 | .69 | 32.47 | 114 | |
| Low | A3-4520 | Inflow | 4,520 | FA | 4.73 | 19.5 | 302 | 63.9 | 8.69 | 5.59 | < .01 | 2,770 | 2,390 |
| Low | A3-4544 | Inflow | 4,544 | FA | 5.05 | 23.0 | 268 | 52.4 | 9.27 | 4.44 | < .01 | 2,060 | 1,940 |
| Low | A3-4581 | Stream | 4,581 | UFA | 8.03 | 15.0 | 49.5 | 3.04 | 2.50 | .67 | 34.57 | 115 | 108 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | pH | Temperature | Calcium | Magnesium | Sodium | Potassium | Alkalinity | Sulfate | Sulfate ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | | Celcius | mg/L | mg/L | mg/L | mg/L | mg/L as CaCO3 | mg/L | mg/L |
| Low | A3-4581 | Stream | 4,581 | FA | 8.03 | 15.0 | 51.6 | 3.13 | 2.67 | .66 | 34.57 | 115 | 112 |
| Low | A3-4581 | Stream | 4,581 | RA | 8.03 | 15.0 | 55.3 | 3.15 | 2.57 | .69 | 34.57 | 115 | |
| Low | A3-4713 | Stream | 4,713 | UFA | 7.99 | 15.0 | 49.6 | 3.00 | 2.55 | .66 | 32.50 | 115 | 106 |
| Low | A3-4713 | Stream | 4,713 | FA | 7.99 | 15.0 | 50.9 | 3.05 | 2.51 | .65 | 32.50 | 115 | 111 |
| Low | A3-4713 | Stream | 4,713 | RA | 7.99 | 15.0 | 50.4 | 3.06 | 2.52 | .64 | 32.50 | 115 | 110 |
| Low | A3-4806 | Stream | 4,806 | UFA | 7.74 | 14.5 | 53.1 | 3.05 | 2.64 | .65 | 31.04 | 115 | 105 |
| Low | A3-4806 | Stream | 4,806 | FA | 7.74 | 14.5 | 49.6 | 3.11 | 2.51 | .65 | 31.04 | 115 | 106 |
| Low | A3-4806 | Stream | 4,806 | RA | 7.74 | 14.5 | 54.4 | 3.07 | 2.42 | .63 | 31.04 | 115 | |
| Low | A3-4886 | Inflow | 4,886 | FU | 6.05 | 14.5 | | | | | 33.63 | 1,670 | |
| Low | A3-4916A | Stream | 4,916 | FU | 7.94 | 14.5 | | | | | | 118 | |
| Low | A3-4916B | Stream | 4,916 | UFA | 7.83 | 14.0 | 51.1 | 3.11 | 2.59 | .70 | 33.95 | 118 | 113 |
| Low | A3-4916B | Stream | 4,916 | FA | 7.83 | 14.0 | 51.9 | 3.13 | 2.58 | .71 | 33.95 | 118 | 115 |
| Low | A3-4916B | Stream | 4,916 | RA | 7.83 | 14.0 | 53.2 | 3.13 | 2.44 | .67 | 33.95 | 118 | |
| Low | A3-4951 | Inflow | 4,951 | FA | 8.07 | 14.0 | 26.3 | 1.39 | 1.42 | .36 | 30.53 | 43.2 | 45.02 |
| Low | A3-4951 | Inflow | 4,951 | RA | 8.07 | 14.0 | 25.4 | 1.31 | 1.33 | .39 | 30.53 | 43.2 | 41.27 |
| Low | A3-5016 | Stream | 5,016 | UFA | 7.90 | 14.0 | 50.8 | 3.02 | 2.50 | .68 | 32.41 | 114 | 108 |
| Low | A3-5016 | Stream | 5,016 | FA | 7.90 | 14.0 | 49.0 | 2.92 | 2.42 | .68 | 32.41 | 114 | 104 |
| Low | A3-5016 | Stream | 5,016 | RA | 7.90 | 14.0 | 53.3 | 3.09 | 2.40 | .62 | 32.41 | 114 | |
| Low | A3-5038 | Inflow | 5,038 | UFA | 6.14 | 16.5 | 400 | 35.9 | 13.4 | 22.6 | 49.19 | 1,580 | 1,460 |
| Low | A3-5038 | Inflow | 5,038 | FA | 6.14 | 16.5 | 403 | 34.3 | 14.0 | 23.1 | 49.19 | 1,580 | 1,400 |
| Low | A3-5038 | Inflow | 5,038 | RA | 6.14 | 16.5 | 441 | 34.2 | 14.3 | 24.8 | 49.19 | 1,580 | 1,420 |
| Low | A3-5131 | Stream | 5,131 | UFA | 7.79 | 14.0 | 50.8 | 3.10 | 2.52 | .72 | 33.23 | 115 | 112 |
| Low | A3-5131 | Stream | 5,131 | FA | 7.79 | 14.0 | 51.5 | 3.08 | 2.59 | .64 | 33.23 | 115 | 113 |
| Low | A3-5131 | Stream | 5,131 | RA | 7.79 | 14.0 | 54.7 | 3.13 | 2.46 | .68 | 33.23 | 115 | |
| Low | A3-5161 | Inflow | 5,161 | FA | 7.02 | 15.0 | 192 | 3.87 | 4.01 | .50 | 48.41 | 469 | 429 |
| Low | A3-5221 | Inflow | 5,221 | FA | 7.52 | 13.0 | 183 | 3.56 | 3.78 | .60 | 42.78 | 450 | 418 |
| Low | A3-5251 | Stream | 5,251 | UFA | 7.84 | 14.0 | 51.8 | 3.04 | 2.53 | .68 | 33.70 | 120 | 114 |
| Low | A3-5251 | Stream | 5,251 | FA | 7.84 | 14.0 | 51.7 | 3.04 | 2.51 | .65 | 33.70 | 120 | 110 |
| Low | A3-5251 | Stream | 5,251 | RA | 7.84 | 14.0 | 51.6 | 3.03 | 2.47 | .67 | 33.70 | 120 | 112 |
| Low | A3-5269 | Inflow | 5,269 | FU | 3.27 | 18.0 | | | | | < .01 | 681 | |
| Low | A3-5295 | Inflow | 5,295 | FA | 2.42 | 14.0 | 59.8 | 13.1 | 2.66 | .28 | | 956 | 754 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | pH | Temperature | Calcium | Magnesium | Sodium | Potassium | Alkalinity | Sulfate | Sulfate ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | | Celcius | mg/L | mg/L | mg/L | mg/L | mg/L as CaCO3 | mg/L | mg/L |
| Low | A3-5306 | Stream | 5,306 | UFA | 7.81 | 13.5 | 52.6 | 2.98 | 2.54 | .70 | 34.15 | 121 | 111 |
| Low | A3-5306 | Stream | 5,306 | FA | 7.81 | 13.5 | 52.9 | 3.07 | 2.53 | .64 | 34.15 | 121 | 115 |
| Low | A3-5306 | Stream | 5,306 | RA | 7.81 | 13.5 | 56.0 | 3.06 | 2.40 | .63 | 34.15 | 121 | |
| Low | A3-5356 | Inflow | 5,356 | UFA | 3.67 | 11.5 | 277 | 21.0 | 7.00 | 1.63 | < .01 | 1,100 | 937 |
| Low | A3-5356 | Inflow | 5,356 | FA | 3.67 | 11.5 | 263 | 21.1 | 6.86 | 1.56 | < .01 | 1,100 | 965 |
| Low | A3-5356 | Inflow | 5,356 | RA | 3.67 | 11.5 | 292 | 23.4 | 6.95 | 1.86 | < .01 | 1,100 | 923 |
| Low | A3-5448 | Stream | 5,448 | UFA | 7.89 | 12.0 | 53.2 | 3.08 | 2.59 | .63 | 33.10 | 123 | 123 |
| Low | A3-5448 | Stream | 5,448 | FA | 7.89 | 12.0 | 54.0 | 3.22 | 2.53 | .69 | 33.10 | 123 | 121 |
| Low | A3-5448 | Stream | 5,448 | RA | 7.89 | 12.0 | 57.6 | 3.14 | 2.54 | .67 | 33.10 | 123 | |
| Low | A3-5536 | Stream | 5,536 | UFA | 7.89 | 11.5 | 52.1 | 2.94 | 2.44 | .68 | 33.48 | 123 | 114 |
| Low | A3-5536 | Stream | 5,536 | FA | 7.89 | 11.5 | 53.8 | 3.13 | 2.52 | .71 | 33.48 | 123 | 118 |
| Low | A3-5536 | Stream | 5,536 | RA | 7.89 | 11.5 | 52.6 | 3.05 | 2.46 | .63 | 33.48 | 123 | 115 |
| Low | A3-5756 | Stream | 5,756 | UFA | 7.79 | 11.0 | 51.8 | 3.06 | 2.47 | .65 | 34.57 | 121 | 116 |
| Low | A3-5756 | Stream | 5,756 | FA | 7.79 | 11.0 | 53.4 | 3.15 | 2.61 | .62 | 34.57 | 121 | 116 |
| Low | A3-5756 | Stream | 5,756 | RA | 7.79 | 11.0 | 58.2 | 3.10 | 2.44 | .59 | 34.57 | 121 | |
| Low | A3-5815 | Inflow | 5,815 | FU | 6.49 | 12.0 | | | | | 32.64 | 199 | |
| Low | A3-5858 | Inflow | 5,858 | FA | 6.19 | 15.0 | 110 | 7.27 | 4.64 | 4.11 | 20.68 | 344 | 321 |
| Low | A3-5965 | Inflow | 5,965 | FA | 6.71 | 21.0 | 99.9 | 2.36 | 3.01 | .84 | 27.23 | 233 | 227 |
| Low | A3-6038 | Stream | 6,038 | UFA | 7.78 | 10.5 | 51.5 | 2.94 | 2.51 | .66 | 31.51 | 123 | 113 |
| Low | A3-6038 | Stream | 6,038 | FA | 7.78 | 10.5 | 53.7 | 3.09 | 2.57 | .59 | 31.51 | 123 | 120 |
| Low | A3-6038 | Stream | 6,038 | RA | 7.78 | 10.5 | 52.4 | 3.02 | 2.48 | .65 | 31.51 | 123 | 115 |
| Low | A3-6126 | Stream | 6,126 | UFA | 7.66 | 10.0 | 51.2 | 3.07 | 2.40 | .66 | 35.08 | 125 | 112 |
| Low | A3-6126 | Stream | 6,126 | FA | 7.66 | 10.0 | 54.0 | 3.12 | 2.59 | .63 | 35.08 | 125 | 119 |
| Low | A3-6126 | Stream | 6,126 | RA | 7.66 | 10.0 | 57.6 | 3.22 | 2.53 | .62 | 35.08 | 125 | |
| Low | A3-6131 | Inflow | 6,131 | FA | 6.88 | 12.0 | 126 | 2.93 | 3.58 | .71 | 30.76 | 299 | 279 |
| Low | A3-6131 | Inflow | 6,131 | RA | 6.88 | 12.0 | 121 | 2.98 | 3.59 | .68 | 30.76 | 299 | 279 |
| Low | A3-6150 | Inflow | 6,150 | UFA | 5.46 | 17.0 | 187 | 25.4 | 5.77 | 4.13 | < .01 | 1,030 | 885 |
| Low | A3-6150 | Inflow | 6,150 | FA | 5.46 | 17.0 | 183 | 26.5 | 5.79 | 4.45 | < .01 | 1,030 | 860 |
| Low | A3-6150 | Inflow | 6,150 | RA | 5.46 | 17.0 | 209 | 25.2 | 6.00 | 4.19 | < .01 | 1,030 | 869 |
| Low | A3-6265 | Stream | 6,265 | UFA | 7.79 | 10.0 | 53.8 | 3.23 | 2.57 | .70 | 37.34 | 126 | 121 |
| Low | A3-6265 | Stream | 6,265 | FA | 7.79 | 10.0 | 54.5 | 3.24 | 2.52 | .64 | 37.34 | 126 | 118 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | pH | Temperature | Calcium | Magnesium | Sodium | Potassium | Alkalinity | Sulfate | Sulfate ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | | Celcius | mg/L | mg/L | mg/L | mg/L | mg/L as CaCO3 | mg/L | mg/L |
| Low | A3-6265 | Stream | 6,265 | RA | 7.79 | 10.0 | 57.4 | 3.14 | 2.46 | .67 | 37.34 | 126 | |
| Low | A3-6465 | Stream | 6,465 | UFA | 7.64 | 8.0 | 54.4 | 3.11 | 2.51 | .66 | 32.50 | 128 | 121 |
| Low | A3-6465 | Stream | 6,465 | FA | 7.64 | 8.0 | 54.8 | 3.20 | 2.56 | .67 | 32.50 | 128 | 122 |
| Low | A3-6465 | Stream | 6,465 | RA | 7.64 | 8.0 | 57.7 | 3.23 | 2.55 | .73 | 32.50 | 128 | |
| Low | A3-6745 | Stream | 6,745 | UFA | 7.56 | 8.0 | 54.8 | 3.18 | 2.57 | .69 | 34.58 | 127 | 121 |
| Low | A3-6745 | Stream | 6,745 | FA | 7.56 | 8.0 | 53.8 | 3.05 | 2.45 | .64 | 34.58 | 127 | 119 |
| Low | A3-6745 | Stream | 6,745 | RA | 7.56 | 8.0 | 54.2 | 3.14 | 2.54 | .63 | 34.58 | 127 | 120 |
| Low | A3-6994 | Stream | 6,994 | UFA | 7.57 | 9.0 | 53.2 | 3.21 | 2.52 | .67 | 35.33 | 127 | 118 |
| Low | A3-6994 | Stream | 6,994 | FA | 7.57 | 9.0 | 56.7 | 3.32 | 2.76 | .66 | 35.33 | 127 | 123 |
| Low | A3-6994 | Stream | 6,994 | RA | 7.57 | 9.0 | 57.3 | 3.32 | 2.61 | .69 | 35.33 | 127 | |
| Low | A3-7049 | Inflow | 7,049 | FA | 5.79 | 14.5 | 141 | 9.68 | 4.83 | 3.00 | 3.92 | 440 | 406 |
| Low | A3-7177 | Stream | 7,177 | UFA | 7.41 | 7.0 | 53.9 | 3.12 | 2.50 | .69 | 34.66 | 128 | 118 |
| Low | A3-7177 | Stream | 7,177 | FA | 7.41 | 7.0 | 54.4 | 3.21 | 2.62 | .62 | 34.66 | 128 | 122 |
| Low | A3-7177 | Stream | 7,177 | RA | 7.41 | 7.0 | 55.8 | 3.14 | 2.44 | .70 | 34.66 | 128 | |
| Low | A3-7201 | Inflow | 7,201 | FA | 7.95 | 9.0 | 50.7 | 3.05 | 3.34 | .56 | 45.89 | 102 | 99.78 |
| Low | A3-7201 | Inflow | 7,201 | RA | 7.95 | 9.0 | 50.3 | 3.00 | 2.97 | .53 | 45.89 | 102 | |
| Low | A3-7306 | Stream | 7,306 | UFA | 7.41 | 7.0 | 55.8 | 3.29 | 2.69 | .71 | 32.98 | 131 | 130 |
| Low | A3-7306 | Stream | 7,306 | FA | 7.41 | 7.0 | 55.4 | 3.28 | 2.66 | .70 | 32.98 | 131 | 125 |
| Low | A3-7306 | Stream | 7,306 | RA | 7.41 | 7.0 | 56.1 | 3.27 | 2.44 | .77 | 32.98 | 131 | |
| Low | A3-7585 | Stream | 7,585 | UFA | 7.64 | 7.0 | 53.9 | 3.21 | 2.53 | .73 | 35.01 | 131 | 124 |
| Low | A3-7585 | Stream | 7,585 | FA | 7.64 | 7.0 | 54.6 | 3.25 | 2.51 | .64 | 35.01 | 131 | 122 |
| Low | A3-7585 | Stream | 7,585 | RA | 7.64 | 7.0 | 58.0 | 3.20 | 2.44 | .64 | 35.01 | 131 | |
| Low | A3-7750 | Inflow | 7,750 | UFA | 5.97 | 10.0 | 366 | 24.1 | 11.2 | 5.86 | 14.00 | 1,150 | 1,070 |
| Low | A3-7750 | Inflow | 7,750 | FA | 5.97 | 10.0 | 364 | 24.2 | 11.2 | 5.93 | 14.00 | 1,150 | 1,040 |
| Low | A3-7750 | Inflow | 7,750 | RA | 5.97 | 10.0 | 398 | 27.2 | 10.9 | 5.80 | 14.00 | 1,150 | 1,050 |
| Low | A3-7858 | Stream | 7,858 | UFA | 7.39 | 6.5 | 53.2 | 3.10 | 2.52 | .73 | 34.17 | 132 | 119 |
| Low | A3-7858 | Stream | 7,858 | FA | 7.39 | 6.5 | 54.7 | 3.28 | 2.63 | .70 | 34.17 | 132 | 124 |
| Low | A3-7858 | Stream | 7,858 | RA | 7.39 | 6.5 | 58.7 | 3.35 | 2.64 | .76 | 34.17 | 132 | |
| High | A3HF-4023 | Stream | 3,909 | FU | 7.36 | 9.0 | | | | | | 97.0 | |
| High | A3HF-4161 | Inflow | 4,033 | FU | 7.79 | 4.5 | | | | | | 32.9 | |
| High | A3HF-4166 | Stream | 4,166 | FU | 7.20 | 9.5 | | | | | | 94.4 | |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | pH | Temperature | Calcium | Magnesium | Sodium | Potassium | Alkalinity | Sulfate | Sulfate ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | | Celcius | mg/L | mg/L | mg/L | mg/L | mg/L as CaCO3 | mg/L | mg/L |
| High | A3HF-4186 | Inflow | 4,186 | FU | 7.68 | 6.5 | | | | | | 66.3 | |
| High | A3HF-4250 | Stream | 4,250 | FU | 7.52 | 9.0 | | | | | | 95.1 | |
| High | A3HF-4385 | Inflow | 4,385 | FU | 4.35 | 4.0 | | | | | | 968 | |
| High | A3HF-WP142 | Inflow | 4,533 | FU | 4.42 | 12.5 | | | | | | 3,450 | |
| High | A3HF-4580 | Inflow | 4,586 | FU | 4.30 | 5.0 | | | | | | | |
| High | A3HF-4892 | Inflow | 4,886 | FU | 5.37 | 5.0 | | | | | | 973 | |
| High | A3HF-4916 | Stream | 4,916 | FU | 7.43 | 10.0 | | | | | | 97.5 | |
| High | A3HF-4951 | Inflow | 4,951 | FU | 7.12 | 5.5 | | | | | | 32.5 | |
| High | A3HF-5038 | Inflow | 5,038 | FU | 6.14 | 11.5 | | | | | | 1,110 | |
| High | A3HF-5221 | Inflow | 5,221 | FU | 7.40 | 8.5 | | | | | | 416 | |
| High | A3HF-5356 | Inflow | 5,356 | FU | 4.09 | 12.5 | | | | | | 1,890 | |
| High | A3HF-5536 | Stream | 5,536 | FU | 7.36 | 9.5 | | | | | | 101 | |
| High | A3HF-5855 | Inflow | 5,858 | FU | 5.97 | 4.0 | | | | | | 75.5 | |
| High | A3HF-6150 | Inflow | 6,150 | FU | 4.81 | 9.0 | | | | | | 1,490 | |
| High | A3HF-6745 | Stream | 6,745 | FU | 7.32 | 9.0 | | | | | | 106 | |
| High | A3HF-7100 | Inflow | 7,201 | FU | 5.36 | 10.5 | | | | | | 452 | |
| High | A3HF-7306 | Stream | 7,306 | FU | 7.37 | 10.0 | | | | | | 108 | |
| High | A3HF-7750 | Inflow | 7,750 | FU | 3.41 | 9.0 | | | | | | 575 | |
| High | A3HF-7858A | Stream | 7,858 | FU | 7.14 | 10.0 | | | | | | 119 | |
| High | A3HF-7858B | Stream | 7,858 | FU | 7.13 | 10.0 | | | | | | 118 | |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

[Filter: UFA, ultrafiltration, FA, 0.45-micrometer, RA, total rec
coupled plasma; mg/L, milligrams per literμg/L, micrograms p

| Study | Sample identification | Source | Distance | Filter | Chloride | Bromide | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | mg/L | mg/L | mg/L | μg/L | μg/L | μg/L | μg/L | μg/L | μg/L | μg/L |
| Low | A3-3655 | Stream | 3,655 | UFA | .74 | .05 | 7.45 | 47.4 | .16 | 26.9 | .51 | .36 | .20 | 15.0 |
| Low | A3-3655 | Stream | 3,655 | FA | .74 | .05 | 8.35 | 55.5 | .15 | 26.9 | .53 | .15 | .18 | 11.2 |
| Low | A3-3655 | Stream | 3,655 | RA | .74 | .05 | 7.96 | 55.8 | .16 | 26.8 | .52 | .10 | .16 | 2.25 |
| Low | A3-4023 | Stream | 3,909 | UFA | .82 | 1.22 | 7.51 | 47.7 | .13 | 29.2 | .52 | .32 | .16 | 3.73 |
| Low | A3-4023 | Stream | 3,909 | FA | .82 | 1.22 | 8.30 | 47.3 | .13 | 25.8 | .54 | .07 | .15 | 1.99 |
| Low | A3-4023 | Stream | 3,909 | RA | .82 | 1.22 | 7.87 | 59.7 | .14 | 25.3 | .54 | .08 | .18 | 2.03 |
| Low | A3-4161 | Inflow | 4,033 | FA | 1.53 | .05 | 9.96 | 157 | .20 | 6.34 | .32 | .10 | .01 | .86 |
| Low | A3-4161 | Inflow | 4,033 | RA | 1.53 | .05 | 10.2 | 47.6 | .20 | 6.37 | .34 | .16 | .03 | .57 |
| Low | A3-4166 | Stream | 4,166 | UFA | .83 | 1.22 | 7.72 | 71.3 | .16 | 29.9 | .49 | .39 | .17 | 14.7 |
| Low | A3-4166 | Stream | 4,166 | FA | .83 | 1.22 | 7.81 | 88.6 | .16 | 28.5 | .51 | .30 | .16 | 7.60 |
| Low | A3-4166 | Stream | 4,166 | RA | .83 | 1.22 | 8.15 | 66.3 | .12 | 26.2 | .52 | .12 | .16 | 2.33 |
| Low | A3-4186 | Inflow | 4,186 | UFA | .17 | .05 | 5.43 | 18.7 | .20 | 35.3 | 1.11 | .28 | .01 | 6.33 |
| Low | A3-4186 | Inflow | 4,186 | FA | .17 | .05 | 5.62 | 42.2 | .17 | 30.6 | 1.33 | .08 | .003 | 5.61 |
| Low | A3-4186 | Inflow | 4,186 | RA | .17 | .05 | 5.54 | 15.2 | .20 | 34.5 | 1.43 | .13 | .003 | 5.62 |
| Low | A3-4250A | Stream | 4,250 | UFA | .71 | 1.10 | 7.08 | 65.7 | .20 | 27.7 | .54 | .41 | .14 | 18.1 |
| Low | A3-4250A | Stream | 4,250 | FA | .71 | 1.10 | 8.44 | 52.0 | .17 | 27.9 | .70 | .13 | .16 | 5.04 |
| Low | A3-4250A | Stream | 4,250 | RA | .71 | 1.10 | 7.57 | 49.7 | .16 | 28.1 | .65 | .10 | .15 | 2.51 |
| Low | A3-4250B | Stream | 4,250 | UFA | .77 | 1.11 | 7.49 | 36.5 | .19 | 27.1 | .49 | .27 | .13 | 6.23 |
| Low | A3-4250B | Stream | 4,250 | FA | .77 | 1.11 | 8.00 | 47.2 | .20 | 26.1 | .56 | .11 | .17 | 4.77 |
| Low | A3-4250B | Stream | 4,250 | RA | .77 | 1.11 | 7.86 | 52.8 | .11 | 26.6 | .62 | .10 | .13 | 2.50 |
| Low | A3-4300 | Inflow | 4,300 | FA | 10.7 | .06 | 11.0 | 21.9 | .05 | 18.5 | 1.83 | .23 | .02 | 18.8 |
| Low | A3-4353 | Inflow | 4,353 | FA | 21.3 | .49 | 39.7 | 18,477 | .27 | 18.1 | 507 | .28 | 53.0 | 4,019 |
| Low | A3-4385 | Inflow | 4,385 | FU | 36.1 | .34 | | | | | | | | |
| Low | A3-4473 | Stream | 4,473 | UFA | .65 | 1.06 | 7.27 | 35.6 | .18 | 26.3 | .62 | .32 | .13 | 3.44 |
| Low | A3-4473 | Stream | 4,473 | FA | .65 | 1.06 | 7.81 | 44.8 | .11 | 30.2 | .67 | .10 | .14 | 3.28 |
| Low | A3-4473 | Stream | 4,473 | RA | .65 | 1.06 | 7.54 | 50.7 | .14 | 27.6 | .72 | .09 | .14 | 2.93 |
| Low | A3-4520 | Inflow | 4,520 | FA | | .05 | 42.9 | 27,557 | .20 | 20.3 | 385 | .48 | 124 | 1,039 |
| Low | A3-4544 | Inflow | 4,544 | FA | 8.07 | .05 | 31.1 | 16,420 | .30 | 19.9 | 289 | .26 | 55.7 | 698 |
| Low | A3-4581 | Stream | 4,581 | UFA | .68 | 1.04 | 7.35 | 40.1 | .22 | 30.3 | .70 | .48 | .16 | 23.5 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Chloride | Bromide | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Low | A3-4581 | Stream | 4,581 | FA | .68 | 1.04 | 8.39 | 56.7 | .16 | 27.1 | .85 | .15 | .16 | 12.4 |
| Low | A3-4581 | Stream | 4,581 | RA | .68 | 1.04 | 7.78 | 65.1 | .21 | 25.9 | .77 | .07 | .20 | 3.04 |
| Low | A3-4713 | Stream | 4,713 | UFA | .81 | 1.05 | 7.60 | 43.3 | .14 | 27.5 | .62 | .28 | .15 | 7.90 |
| Low | A3-4713 | Stream | 4,713 | FA | .81 | 1.05 | 7.74 | 51.0 | .16 | 28.5 | .75 | .12 | .15 | 2.89 |
| Low | A3-4713 | Stream | 4,713 | RA | .81 | 1.05 | 7.85 | 54.2 | .12 | 25.7 | .76 | .10 | .15 | 2.75 |
| Low | A3-4806 | Stream | 4,806 | UFA | .78 | 1.04 | 7.61 | 60.3 | .19 | 30.4 | .70 | .19 | .18 | 5.14 |
| Low | A3-4806 | Stream | 4,806 | FA | .78 | 1.04 | 7.81 | 70.3 | .15 | 32.0 | .80 | .13 | .16 | 6.86 |
| Low | A3-4806 | Stream | 4,806 | RA | .78 | 1.04 | 7.58 | 57.6 | .13 | 27.8 | .78 | .10 | .15 | 3.16 |
| Low | A3-4886 | Inflow | 4,886 | FU | | .05 | | | | | | | | |
| Low | A3-4916A | Stream | 4,916 | FU | .75 | 1.04 | | | | | | | | |
| Low | A3-4916B | Stream | 4,916 | UFA | .70 | 1.05 | 7.59 | 46.5 | .20 | 25.9 | .70 | .56 | .16 | 6.11 |
| Low | A3-4916B | Stream | 4,916 | FA | .70 | 1.05 | 8.09 | 56.6 | .10 | 26.1 | .80 | .16 | .16 | 3.13 |
| Low | A3-4916B | Stream | 4,916 | RA | .70 | 1.05 | 7.73 | 60.5 | .14 | 25.8 | .83 | .11 | .17 | 2.99 |
| Low | A3-4951 | Inflow | 4,951 | FA | .13 | .05 | 5.05 | 44.5 | .16 | 8.68 | .15 | .10 | .03 | 2.64 |
| Low | A3-4951 | Inflow | 4,951 | RA | .13 | .05 | 4.72 | 44.9 | .15 | 8.34 | .13 | .10 | .03 | 2.48 |
| Low | A3-5016 | Stream | 5,016 | UFA | .69 | 1.00 | 7.51 | 40.4 | .18 | 27.9 | .73 | .25 | .15 | 12.4 |
| Low | A3-5016 | Stream | 5,016 | FA | .69 | 1.00 | 7.52 | 47.7 | .14 | 31.0 | .82 | .12 | .16 | 3.40 |
| Low | A3-5016 | Stream | 5,016 | RA | .69 | 1.00 | 7.90 | 65.2 | .16 | 27.5 | .82 | .15 | .16 | 3.18 |
| Low | A3-5038 | Inflow | 5,038 | UFA | 3.23 | .05 | 16.2 | 314 | .33 | 29.8 | 13.2 | .37 | 45.9 | 19.8 |
| Low | A3-5038 | Inflow | 5,038 | FA | 3.23 | .05 | 15.9 | 343 | .29 | 28.0 | 13.7 | .22 | 48.8 | 19.6 |
| Low | A3-5038 | Inflow | 5,038 | RA | 3.23 | .05 | 16.1 | 359 | .24 | 26.4 | 13.2 | .11 | 47.3 | 21.1 |
| Low | A3-5131 | Stream | 5,131 | UFA | .71 | .97 | 7.54 | 40.5 | .14 | 28.4 | .76 | .44 | .19 | 6.97 |
| Low | A3-5131 | Stream | 5,131 | FA | .71 | .97 | 7.96 | 63.2 | .12 | 28.7 | .83 | .14 | .21 | 9.63 |
| Low | A3-5131 | Stream | 5,131 | RA | .71 | .97 | 7.86 | 56.8 | .13 | 27.8 | .85 | .11 | .19 | 3.01 |
| Low | A3-5161 | Inflow | 5,161 | FA | .42 | .05 | 14.6 | 21.0 | .10 | 33.8 | 5.03 | .15 | .04 | 2.57 |
| Low | A3-5221 | Inflow | 5,221 | FA | .56 | .05 | 13.1 | 13.1 | .11 | 40.1 | 14.9 | .12 | .06 | 1.12 |
| Low | A3-5251 | Stream | 5,251 | UFA | .77 | .99 | 7.93 | 51.7 | .20 | 26.5 | .87 | .21 | .17 | 2.62 |
| Low | A3-5251 | Stream | 5,251 | FA | .77 | .99 | 7.71 | 52.1 | .16 | 26.7 | .96 | .15 | .18 | 3.45 |
| Low | A3-5251 | Stream | 5,251 | RA | .77 | .99 | 7.66 | 53.9 | .14 | 27.5 | 1.05 | .14 | .17 | 3.05 |
| Low | A3-5269 | Inflow | 5,269 | FU | 1.09 | .05 | | | | | | | | |
| Low | A3-5295 | Inflow | 5,295 | FA | .68 | .05 | 40.0 | 21,212 | 1.33 | 16.0 | 11.8 | 4.65 | 146 | 692 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Chloride | Bromide | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Low | A3-5306 | Stream | 5,306 | UFA | .70 | 1.01 | 7.58 | 39.1 | .15 | 26.9 | .94 | .42 | .22 | 2.80 |
| Low | A3-5306 | Stream | 5,306 | FA | .70 | 1.01 | 7.89 | 53.6 | .11 | 26.9 | .98 | .11 | .22 | 3.07 |
| Low | A3-5306 | Stream | 5,306 | RA | .70 | 1.01 | 7.65 | 60.1 | .16 | 26.6 | 1.05 | .13 | .24 | 3.81 |
| Low | A3-5356 | Inflow | 5,356 | UFA | 1.25 | .05 | 35.0 | 13,237 | .45 | 15.7 | 51.1 | .39 | 94.8 | 1,010 |
| Low | A3-5356 | Inflow | 5,356 | FA | 1.25 | .05 | 34.1 | 13,069 | .12 | 14.8 | 48.6 | .14 | 91.8 | 1,007 |
| Low | A3-5356 | Inflow | 5,356 | RA | 1.25 | .05 | 38.4 | 13,410 | 1.57 | 21.3 | 49.2 | .42 | 99.3 | 1,002 |
| Low | A3-5448 | Stream | 5,448 | UFA | .72 | .96 | 7.95 | 59.5 | .19 | 26.8 | 1.09 | .24 | .36 | 5.50 |
| Low | A3-5448 | Stream | 5,448 | FA | .72 | .96 | 8.35 | 63.0 | .17 | 26.6 | 1.18 | .14 | .37 | 4.36 |
| Low | A3-5448 | Stream | 5,448 | RA | .72 | .96 | 7.76 | 73.2 | .11 | 24.8 | 1.12 | .14 | .38 | 4.74 |
| Low | A3-5536 | Stream | 5,536 | UFA | .84 | .96 | 7.75 | 39.2 | .21 | 27.6 | 1.10 | .26 | .31 | 6.60 |
| Low | A3-5536 | Stream | 5,536 | FA | .84 | .96 | 7.79 | 56.2 | .15 | 30.2 | 1.15 | .12 | .33 | 5.19 |
| Low | A3-5536 | Stream | 5,536 | RA | .84 | .96 | 7.91 | 65.9 | .17 | 27.8 | 1.14 | .13 | .31 | 4.71 |
| Low | A3-5756 | Stream | 5,756 | UFA | .63 | .94 | 7.49 | 46.8 | .31 | 28.7 | 1.02 | .28 | .33 | 15.5 |
| Low | A3-5756 | Stream | 5,756 | FA | .63 | .94 | 7.86 | 58.2 | .16 | 26.2 | 1.12 | .13 | .35 | 3.88 |
| Low | A3-5756 | Stream | 5,756 | RA | .63 | .94 | 7.67 | 65.9 | .09 | 27.1 | 1.26 | .08 | .34 | 4.48 |
| Low | A3-5815 | Inflow | 5,815 | FU | .40 | .05 | | | | | | | | |
| Low | A3-5858 | Inflow | 5,858 | FA | 1.39 | 1.44 | 18.1 | 309 | .14 | 11.2 | 21.0 | .27 | .14 | 68.5 |
| Low | A3-5965 | Inflow | 5,965 | FA | .36 | .05 | 10.9 | 18.3 | .10 | 50.8 | .39 | .12 | .02 | 2.55 |
| Low | A3-6038 | Stream | 6,038 | UFA | .76 | .95 | 7.42 | 41.8 | .23 | 28.5 | 1.08 | .49 | .33 | 14.2 |
| Low | A3-6038 | Stream | 6,038 | FA | .76 | .95 | 8.13 | 54.8 | .19 | 25.9 | 1.14 | .12 | .31 | 3.49 |
| Low | A3-6038 | Stream | 6,038 | RA | .76 | .95 | 7.91 | 69.3 | .11 | 26.7 | 1.16 | .17 | .30 | 4.48 |
| Low | A3-6126 | Stream | 6,126 | UFA | .77 | .98 | 7.30 | 40.0 | .16 | 28.8 | 1.05 | .24 | .32 | 2.44 |
| Low | A3-6126 | Stream | 6,126 | FA | .77 | .98 | 8.29 | 65.4 | .16 | 26.7 | 1.21 | .11 | .30 | 3.61 |
| Low | A3-6126 | Stream | 6,126 | RA | .77 | .98 | 7.73 | 67.8 | .15 | 27.7 | 1.25 | .14 | .35 | 4.72 |
| Low | A3-6131 | Inflow | 6,131 | FA | .59 | .11 | 11.1 | 18.6 | .08 | 37.1 | 1.33 | .15 | .33 | 1.84 |
| Low | A3-6131 | Inflow | 6,131 | RA | .59 | .11 | 11.3 | 59.8 | .08 | 32.5 | 1.34 | .17 | .35 | 1.78 |
| Low | A3-6150 | Inflow | 6,150 | UFA | 1.71 | .05 | 26.8 | 10,971 | .24 | 32.5 | 91.1 | .45 | 147 | 427 |
| Low | A3-6150 | Inflow | 6,150 | FA | 1.71 | .05 | 26.2 | 11,697 | .06 | 29.4 | 89.8 | .12 | 151 | 444 |
| Low | A3-6150 | Inflow | 6,150 | RA | 1.71 | .05 | 28.1 | 10,698 | .03 | 30.9 | 91.1 | .39 | 156 | 455 |
| Low | A3-6265 | Stream | 6,265 | UFA | .79 | .96 | 7.60 | 52.6 | .18 | 29.4 | 1.28 | .26 | .53 | 4.18 |
| Low | A3-6265 | Stream | 6,265 | FA | .79 | .96 | 7.96 | 60.3 | .11 | 24.8 | 1.27 | .15 | .51 | 3.74 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Chloride | Bromide | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Low | A3-6265 | Stream | 6,265 | RA | .79 | .96 | 7.79 | 77.8 | .19 | 25.9 | 1.37 | .17 | .57 | 4.59 |
| Low | A3-6465 | Stream | 6,465 | UFA | .81 | .95 | 7.87 | 47.1 | .14 | 29.8 | 1.38 | .30 | .58 | 4.70 |
| Low | A3-6465 | Stream | 6,465 | FA | .81 | .95 | 8.14 | 64.7 | .11 | 27.0 | 1.34 | .13 | .56 | 4.42 |
| Low | A3-6465 | Stream | 6,465 | RA | .81 | .95 | 7.81 | 83.7 | .11 | 27.3 | 1.46 | .09 | .61 | 4.80 |
| Low | A3-6745 | Stream | 6,745 | UFA | .90 | .95 | 7.58 | 39.1 | .28 | 27.2 | 1.20 | .27 | .53 | 3.01 |
| Low | A3-6745 | Stream | 6,745 | FA | .90 | .95 | 7.57 | 59.4 | .15 | 30.2 | 1.42 | .11 | .55 | 4.14 |
| Low | A3-6745 | Stream | 6,745 | RA | .90 | .95 | 8.06 | 80.0 | .12 | 25.0 | 1.42 | .12 | .55 | 4.40 |
| Low | A3-6994 | Stream | 6,994 | UFA | .74 | .98 | 7.48 | 157 | .21 | 26.1 | 1.35 | .29 | .50 | 8.51 |
| Low | A3-6994 | Stream | 6,994 | FA | .74 | .98 | 8.33 | 80.0 | .14 | 25.0 | 1.37 | .09 | .63 | 5.60 |
| Low | A3-6994 | Stream | 6,994 | RA | .74 | .98 | 8.26 | 80.5 | | | | | | |
| Low | A3-7049 | Inflow | 7,049 | FA | 1.51 | .05 | 15.8 | 930 | .13 | 57.5 | 45.4 | .11 | .17 | 71.4 |
| Low | A3-7177 | Stream | 7,177 | UFA | .67 | .94 | 7.78 | 38.7 | .19 | 26.2 | 1.50 | .16 | .51 | 6.36 |
| Low | A3-7177 | Stream | 7,177 | FA | .67 | .94 | 8.28 | 61.0 | .17 | 27.1 | 1.82 | .08 | .62 | 4.27 |
| Low | A3-7177 | Stream | 7,177 | RA | .67 | .94 | 7.91 | 76.2 | .10 | 29.9 | 1.85 | .06 | .57 | 4.81 |
| Low | A3-7201 | Inflow | 7,201 | FA | .27 | .05 | 13.1 | 16.7 | .21 | 32.7 | .19 | .07 | .32 | 3.04 |
| Low | A3-7201 | Inflow | 7,201 | RA | .27 | .05 | 11.8 | 22.4 | .18 | 33.3 | .06 | .07 | .01 | 1.05 |
| Low | A3-7306 | Stream | 7,306 | UFA | .82 | .95 | 8.08 | 45.9 | .21 | 28.7 | 2.09 | .30 | .58 | 11.2 |
| Low | A3-7306 | Stream | 7,306 | FA | .82 | .95 | 8.29 | 64.2 | .14 | 29.6 | 2.19 | .16 | .59 | 5.85 |
| Low | A3-7306 | Stream | 7,306 | RA | .82 | .95 | 7.75 | 74.3 | .13 | 26.7 | 2.14 | .07 | .53 | 4.58 |
| Low | A3-7585 | Stream | 7,585 | UFA | .82 | .95 | 7.94 | 40.0 | .24 | 31.9 | 1.96 | .20 | .53 | 5.45 |
| Low | A3-7585 | Stream | 7,585 | FA | .82 | .95 | 8.02 | 57.2 | .15 | 27.8 | 2.03 | .09 | .56 | 5.24 |
| Low | A3-7585 | Stream | 7,585 | RA | .82 | .95 | 7.65 | 72.1 | .10 | 26.2 | 1.98 | .11 | .55 | 4.45 |
| Low | A3-7750 | Inflow | 7,750 | UFA | 8.49 | .17 | 18.3 | 546 | .30 | 52.2 | 40.5 | .38 | 3.41 | 45.2 |
| Low | A3-7750 | Inflow | 7,750 | FA | 8.49 | .17 | 17.9 | 568 | .21 | 46.2 | 39.7 | .09 | 3.25 | 44.9 |
| Low | A3-7750 | Inflow | 7,750 | RA | 8.49 | .17 | 21.1 | 613 | .17 | 43.0 | 41.3 | .07 | 3.71 | 45.2 |
| Low | A3-7858 | Stream | 7,858 | UFA | .82 | .94 | 7.79 | 35.0 | .14 | 26.4 | 1.89 | .20 | .50 | 3.93 |
| Low | A3-7858 | Stream | 7,858 | FA | .82 | .94 | 8.34 | 62.8 | .10 | 27.4 | 1.93 | .07 | .52 | 4.21 |
| Low | A3-7858 | Stream | 7,858 | RA | .82 | .94 | 8.15 | 79.0 | .11 | 27.0 | 2.06 | .08 | .59 | 4.41 |
| High | A3HF-4023 | Stream | 3,909 | FU | 1.19 | 1.11 | | | | | | | | |
| High | A3HF-4161 | Inflow | 4,033 | FU | .90 | | | | | | | | | |
| High | A3HF-4166 | Stream | 4,166 | FU | 1.20 | 1.13 | | | | | | | | |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Chloride | Bromide | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | mg/L | mg/L | mg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| High | A3HF-4186 | Inflow | 4,186 | FU | .28 | | | | | | | | | |
| High | A3HF-4250 | Stream | 4,250 | FU | 1.20 | 1.08 | | | | | | | | |
| High | A3HF-4385 | Inflow | 4,385 | FU | 7.15 | .13 | | | | | | | | |
| High | A3HF-WP142 | Inflow | 4,533 | FU | 26.6 | | | | | | | | | |
| High | A3HF-4580 | Inflow | 4,586 | FU | | | | | | | | | | |
| High | A3HF-4892 | Inflow | 4,886 | FU | 5.17 | | | | | | | | | |
| High | A3HF-4916 | Stream | 4,916 | FU | 1.17 | 1.06 | | | | | | | | |
| High | A3HF-4951 | Inflow | 4,951 | FU | .36 | | | | | | | | | |
| High | A3HF-5038 | Inflow | 5,038 | FU | 2.21 | | | | | | | | | |
| High | A3HF-5221 | Inflow | 5,221 | FU | .50 | | | | | | | | | |
| High | A3HF-5356 | Inflow | 5,356 | FU | 1.46 | | | | | | | | | |
| High | A3HF-5536 | Stream | 5,536 | FU | 1.19 | .99 | | | | | | | | |
| High | A3HF-5855 | Inflow | 5,858 | FU | .53 | | | | | | | | | |
| High | A3HF-6150 | Inflow | 6,150 | FU | 1.20 | | | | | | | | | |
| High | A3HF-6745 | Stream | 6,745 | FU | 1.08 | .96 | | | | | | | | |
| High | A3HF-7100 | Inflow | 7,201 | FU | 1.53 | | | | | | | | | |
| High | A3HF-7306 | Stream | 7,306 | FU | 1.14 | .95 | | | | | | | | |
| High | A3HF-7750 | Inflow | 7,750 | FU | 12.0 | .05 | | | | | | | | |
| High | A3HF-7858A | Stream | 7,858 | FU | 1.41 | .90 | | | | | | | | |
| High | A3HF-7858B | Stream | 7,858 | FU | 1.39 | .91 | | | | | | | | |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

[Filter: UFA, ultrafiltration, FA, 0.45-micrometer, RA, total rec
coupled plasma; mg/L, milligrams per literµg/L, micrograms p

| Study | Sample identification | Source | Distance | Filter | Iron | Lead | Lithium | Manganese | Molybdenum | Nickel | Strontium | Vanadiaum | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Low | A3-3655 | Stream | 3,655 | UFA | 14.5 | 2.40 | 6.97 | 184 | 1.30 | .72 | 511 | .05 | 203 |
| Low | A3-3655 | Stream | 3,655 | FA | 23.2 | 2.40 | 5.21 | 206 | 1.35 | .47 | 539 | .03 | 185 |
| Low | A3-3655 | Stream | 3,655 | RA | 36.6 | 1.08 | 6.76 | 180 | 1.25 | .28 | 488 | .04 | 187 |
| Low | A3-4023 | Stream | 3,909 | UFA | 2.42 | 1.22 | 7.50 | 176 | 1.50 | .45 | 525 | .04 | 187 |
| Low | A3-4023 | Stream | 3,909 | FA | 21.1 | 1.07 | 8.82 | 179 | 1.37 | .26 | 482 | .03 | 168 |
| Low | A3-4023 | Stream | 3,909 | RA | 50.5 | .82 | 8.50 | 265 | 1.36 | .29 | 527 | .03 | 201 |
| Low | A3-4161 | Inflow | 4,033 | FA | 1.84 | 1.14 | 11.3 | .09 | 2.10 | .07 | 579 | .07 | 71.1 |
| Low | A3-4161 | Inflow | 4,033 | RA | 46.5 | .61 | 15.3 | 171 | 1.99 | .09 | 551 | .14 | 95.1 |
| Low | A3-4166 | Stream | 4,166 | UFA | 9.20 | 4.75 | 9.16 | 173 | 1.42 | .80 | 577 | .05 | 206 |
| Low | A3-4166 | Stream | 4,166 | FA | 23.6 | 3.22 | 7.42 | 174 | 1.45 | 1.08 | 533 | .04 | 169 |
| Low | A3-4166 | Stream | 4,166 | RA | 51.8 | .94 | 8.57 | 194 | 1.37 | .27 | 528 | .04 | 210 |
| Low | A3-4186 | Inflow | 4,186 | UFA | 6.56 | 3.89 | 10.7 | 1.20 | 8.47 | .50 | 592 | .04 | 141 |
| Low | A3-4186 | Inflow | 4,186 | FA | 5.39 | 2.40 | 10.0 | 475 | 7.94 | .10 | 600 | .02 | 210 |
| Low | A3-4186 | Inflow | 4,186 | RA | 3.62 | 2.00 | 11.2 | LD | 8.42 | .06 | 592 | .03 | 173 |
| Low | A3-4250A | Stream | 4,250 | UFA | 12.5 | 11.0 | 12.7 | 148 | 2.05 | 4.55 | 534 | .05 | 194 |
| Low | A3-4250A | Stream | 4,250 | FA | 22.1 | 3.47 | 9.79 | 172 | 2.15 | .32 | 550 | .04 | 186 |
| Low | A3-4250A | Stream | 4,250 | RA | 33.2 | .97 | 8.82 | 151 | 2.14 | .25 | 549 | .04 | 181 |
| Low | A3-4250B | Stream | 4,250 | UFA | 2.92 | 1.91 | 8.59 | 153 | 2.15 | .31 | 527 | .04 | 134 |
| Low | A3-4250B | Stream | 4,250 | FA | 53.2 | 2.16 | 9.32 | 163 | 2.05 | .88 | 579 | .03 | 163 |
| Low | A3-4250B | Stream | 4,250 | RA | 32.7 | 1.31 | 8.37 | 154 | 2.03 | .24 | 522 | .03 | 181 |
| Low | A3-4300 | Inflow | 4,300 | FA | 4.52 | 1.17 | 28.1 | 11.2 | .89 | 1.11 | 1,050 | .03 | 865 |
| Low | A3-4353 | Inflow | 4,353 | FA | 85.7 | 905 | 226 | 59,400 | .05 | 93.0 | 1,160 | .04 | 128,000 |
| Low | A3-4385 | Inflow | 4,385 | FU | | | | | | | | | |
| Low | A3-4473 | Stream | 4,473 | UFA | 4.69 | 3.93 | 8.52 | 188 | 2.12 | .29 | 514 | .03 | 162 |
| Low | A3-4473 | Stream | 4,473 | FA | 19.5 | 1.85 | 7.16 | 187 | 2.40 | .31 | 568 | .03 | 181 |
| Low | A3-4473 | Stream | 4,473 | RA | 31.0 | 1.07 | 8.65 | 183 | 2.15 | .26 | 519 | .04 | 194 |
| Low | A3-4520 | Inflow | 4,520 | FA | 43.6 | 61.9 | 142 | 781,000 | .09 | 234 | 1,460 | .04 | 97,400 |
| Low | A3-4544 | Inflow | 4,544 | FA | 45.2 | 12.4 | 90.0 | 575,000 | .06 | 161 | 1,370 | .05 | 69,800 |
| Low | A3-4581 | Stream | 4,581 | UFA | 4.42 | 3.57 | 12.7 | 261 | 2.34 | .88 | 576 | .05 | 237 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Iron | Lead | Lithium | Manganese | Molybdenum | Nickel | Strontium | Vanadiaum | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Low | A3-4581 | Stream | 4,581 | FA | 24.2 | 3.36 | 10.5 | 302 | 2.21 | .55 | 543 | .04 | 241 |
| Low | A3-4581 | Stream | 4,581 | RA | 38.5 | 1.08 | 9.12 | 347 | 2.13 | .33 | 537 | .04 | 223 |
| Low | A3-4713 | Stream | 4,713 | UFA | 11.6 | 7.70 | 8.74 | 263 | 2.21 | .49 | 528 | .03 | 220 |
| Low | A3-4713 | Stream | 4,713 | FA | 19.0 | 1.78 | 8.26 | 263 | 2.23 | .31 | 527 | .03 | 218 |
| Low | A3-4713 | Stream | 4,713 | RA | 31.4 | 1.03 | 8.46 | 265 | 2.14 | .30 | 511 | .03 | 219 |
| Low | A3-4806 | Stream | 4,806 | UFA | 14.2 | 1.80 | 12.4 | 302 | 2.44 | .61 | 573 | .05 | 202 |
| Low | A3-4806 | Stream | 4,806 | FA | 70.0 | 3.51 | 8.28 | 283 | 2.48 | .47 | 562 | .04 | 253 |
| Low | A3-4806 | Stream | 4,806 | RA | 33.3 | 1.07 | 8.73 | 263 | 2.17 | .31 | 515 | .03 | 228 |
| Low | A3-4886 | Inflow | 4,886 | FU | | | | | | | | | |
| Low | A3-4916A | Stream | 4,916 | FU | | | | | | | | | |
| Low | A3-4916B | Stream | 4,916 | UFA | 19.3 | 11.4 | 9.67 | 756 | 2.41 | .47 | 533 | .04 | 245 |
| Low | A3-4916B | Stream | 4,916 | FA | 21.2 | 2.65 | 7.00 | 798 | 2.08 | .44 | 556 | .03 | 249 |
| Low | A3-4916B | Stream | 4,916 | RA | 36.2 | 1.16 | 7.76 | 769 | 2.17 | .42 | 563 | .03 | 272 |
| Low | A3-4951 | Inflow | 4,951 | FA | 4.85 | 1.06 | 3.20 | 556 | 1.38 | .10 | 247 | .03 | 84.1 |
| Low | A3-4951 | Inflow | 4,951 | RA | 10.7 | .42 | 3.63 | 49.6 | 1.37 | .13 | 238 | .03 | 32.2 |
| Low | A3-5016 | Stream | 5,016 | UFA | 6.10 | 2.58 | 8.88 | 433 | 2.32 | .53 | 540 | .05 | 219 |
| Low | A3-5016 | Stream | 5,016 | FA | 20.4 | 1.80 | 8.20 | 434 | 2.43 | .38 | 537 | .03 | 260 |
| Low | A3-5016 | Stream | 5,016 | RA | 32.3 | 1.05 | 8.70 | 444 | 2.06 | .34 | 512 | .03 | 254 |
| Low | A3-5038 | Inflow | 5,038 | UFA | 1,340 | 14.1 | 43.5 | 228,000 | 1.50 | 37.1 | 2,940 | .08 | 12,900 |
| Low | A3-5038 | Inflow | 5,038 | FA | 1,290 | 14.1 | 37.6 | 224,000 | 1.37 | 38.0 | 2,920 | .03 | 12,400 |
| Low | A3-5038 | Inflow | 5,038 | RA | 1,550 | 21.6 | 45.8 | 222,000 | 1.31 | 35.8 | 3,080 | .02 | 12,400 |
| Low | A3-5131 | Stream | 5,131 | UFA | 4.99 | 1.92 | 11.9 | 555 | 2.27 | .51 | 583 | .04 | 249 |
| Low | A3-5131 | Stream | 5,131 | FA | 27.9 | 3.55 | 7.66 | 607 | 2.17 | .44 | 513 | .03 | 265 |
| Low | A3-5131 | Stream | 5,131 | RA | 30.3 | 1.10 | 9.38 | 585 | 2.09 | .40 | 531 | .03 | 261 |
| Low | A3-5161 | Inflow | 5,161 | FA | 6.49 | 1.60 | 8.40 | 71.2 | 4.76 | .72 | 1,661 | .02 | 1,070 |
| Low | A3-5221 | Inflow | 5,221 | FA | 8.70 | 1.54 | 8.06 | 22.3 | 7.61 | .74 | 1,548 | .09 | 3,290 |
| Low | A3-5251 | Stream | 5,251 | UFA | 342 | 4.73 | 8.34 | 554 | 2.03 | .37 | 533 | .04 | 264 |
| Low | A3-5251 | Stream | 5,251 | FA | 19.1 | 1.56 | 6.38 | 592 | 2.14 | .37 | 510 | .03 | 259 |
| Low | A3-5251 | Stream | 5,251 | RA | 33.7 | 1.12 | 8.51 | 547 | 2.15 | .40 | 556 | .04 | 293 |
| Low | A3-5269 | Inflow | 5,269 | FU | | | | | | | | | |
| Low | A3-5295 | Inflow | 5,295 | FA | 163,000 | 525 | 41.0 | 7,280 | .42 | 106 | 628 | .40 | 2,960 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Iron | Lead | Lithium | Manganese | Molybdenum | Nickel | Strontium | Vanadiaum | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Low | A3-5306 | Stream | 5,306 | UFA | 5.11 | 3.25 | 8.70 | 614 | 2.21 | .48 | 554 | .03 | 346 |
| Low | A3-5306 | Stream | 5,306 | FA | 19.9 | 2.52 | 8.10 | 616 | 2.02 | .37 | 502 | .03 | 283 |
| Low | A3-5306 | Stream | 5,306 | RA | 32.1 | 1.27 | 8.43 | 604 | 2.29 | .41 | 598 | .03 | 310 |
| Low | A3-5356 | Inflow | 5,356 | UFA | 18,200 | 1,126 | 77.6 | 84,600 | .01 | 57.0 | 3,020 | .07 | 18,000 |
| Low | A3-5356 | Inflow | 5,356 | FA | 18,900 | 1,105 | 69.1 | 89,700 | .00 | 53.5 | 2,880 | .01 | 17,300 |
| Low | A3-5356 | Inflow | 5,356 | RA | 21,200 | 1,259 | 69.8 | 85,300 | .47 | 56.7 | 2,870 | 1.10 | 17,900 |
| Low | A3-5448 | Stream | 5,448 | UFA | 7.80 | 2.84 | 12.4 | 799 | 2.05 | .53 | 528 | .04 | 387 |
| Low | A3-5448 | Stream | 5,448 | FA | 25.4 | 2.31 | 3.38 | 820 | 2.15 | .53 | 546 | .03 | 363 |
| Low | A3-5448 | Stream | 5,448 | RA | 41.0 | 1.82 | 8.12 | 783 | 1.93 | .52 | 542 | .03 | 361 |
| Low | A3-5536 | Stream | 5,536 | UFA | 9.94 | 2.67 | 10.8 | 712 | 1.92 | .93 | 530 | .04 | 403 |
| Low | A3-5536 | Stream | 5,536 | FA | 23.7 | 2.09 | 7.71 | 718 | 2.27 | .48 | 538 | .03 | 389 |
| Low | A3-5536 | Stream | 5,536 | RA | 47.0 | 1.71 | 8.30 | 697 | 1.89 | .45 | 533 | .03 | 360 |
| Low | A3-5756 | Stream | 5,756 | UFA | 10.6 | 11.4 | 13.6 | 667 | 2.23 | 1.03 | 587 | .08 | 320 |
| Low | A3-5756 | Stream | 5,756 | FA | 22.2 | 1.65 | 8.40 | 765 | 2.16 | .51 | 585 | .03 | 374 |
| Low | A3-5756 | Stream | 5,756 | RA | 37.1 | 1.78 | 8.85 | 695 | 2.04 | .58 | 547 | .03 | 396 |
| Low | A3-5815 | Inflow | 5,815 | FU | | | | | | | | | |
| Low | A3-5858 | Inflow | 5,858 | FA | 2.02 | .36 | 53.8 | 21,900 | .06 | 24.1 | 964 | .02 | 4,440 |
| Low | A3-5965 | Inflow | 5,965 | FA | 6.69 | .24 | 6.34 | 11.8 | .76 | .69 | 1,143 | .03 | 189 |
| Low | A3-6038 | Stream | 6,038 | UFA | 21.7 | 16.5 | 8.99 | 687 | 2.19 | .99 | 598 | .05 | 387 |
| Low | A3-6038 | Stream | 6,038 | FA | 20.0 | 3.02 | 6.39 | 718 | 1.99 | .53 | 551 | .02 | 361 |
| Low | A3-6038 | Stream | 6,038 | RA | 42.8 | 1.90 | 7.74 | 704 | 1.84 | .47 | 517 | .03 | 384 |
| Low | A3-6126 | Stream | 6,126 | UFA | 5.71 | 3.65 | 8.29 | 744 | 2.14 | .54 | 581 | .03 | 323 |
| Low | A3-6126 | Stream | 6,126 | FA | 20.5 | 4.20 | 6.54 | 783 | 2.01 | .53 | 551 | .02 | 381 |
| Low | A3-6126 | Stream | 6,126 | RA | 39.5 | 1.85 | 9.44 | 798 | 2.10 | .83 | 568 | .03 | 429 |
| Low | A3-6131 | Inflow | 6,131 | FA | 2.86 | .44 | 7.12 | 129 | 1.45 | .38 | 1,626 | .03 | 493 |
| Low | A3-6131 | Inflow | 6,131 | RA | 51.7 | .63 | 7.16 | 131 | 1.40 | .30 | 1,529 | .07 | 502 |
| Low | A3-6150 | Inflow | 6,150 | UFA | 13,200 | 441 | 70.4 | 181,000 | .19 | 97.2 | 1,520 | .05 | 24,900 |
| Low | A3-6150 | Inflow | 6,150 | FA | 13,000 | 414 | 70.4 | 177,000 | .16 | 98.5 | 1,540 | .01 | 23,100 |
| Low | A3-6150 | Inflow | 6,150 | RA | 13,100 | 478 | 81.5 | 176,000 | .24 | 99.8 | 1,490 | .05 | 25,300 |
| Low | A3-6265 | Stream | 6,265 | UFA | 9.10 | 4.98 | 12.6 | 1,170 | 2.05 | .81 | 573 | .04 | 456 |
| Low | A3-6265 | Stream | 6,265 | FA | 20.4 | 1.12 | 7.50 | 1,080 | 1.88 | .72 | 530 | .02 | 425 |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Iron | Lead | Lithium | Manganese | Molybdenum | Nickel | Strontium | Vanadiaum | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| Low | A3-6265 | Stream | 6,265 | RA | 70.3 | 1.92 | 8.34 | 1,060 | 1.99 | .70 | 542 | .02 | 472 |
| Low | A3-6465 | Stream | 6,465 | UFA | 8.03 | 6.37 | 10.2 | 1,220 | 2.20 | .85 | 552 | .04 | 481 |
| Low | A3-6465 | Stream | 6,465 | FA | 39.6 | 2.19 | 8.20 | 1,260 | 2.01 | .77 | 539 | .03 | 450 |
| Low | A3-6465 | Stream | 6,465 | RA | 76.5 | 2.30 | 8.88 | 1,300 | 2.03 | .77 | 547 | .03 | 519 |
| Low | A3-6745 | Stream | 6,745 | UFA | 10.5 | 5.18 | 8.50 | 1,130 | 2.12 | .92 | 566 | .04 | 410 |
| Low | A3-6745 | Stream | 6,745 | FA | 35.4 | 1.49 | 7.18 | 1,170 | 2.25 | .90 | 570 | .02 | 438 |
| Low | A3-6745 | Stream | 6,745 | RA | 66.7 | 1.86 | 7.94 | 1,180 | 1.92 | .82 | 546 | .02 | 481 |
| Low | A3-6994 | Stream | 6,994 | UFA | 5.68 | 3.25 | 9.52 | 1,160 | 1.88 | 1.41 | 533 | .03 | 464 |
| Low | A3-6994 | Stream | 6,994 | FA | 89.1 | 2.30 | 8.85 | 1,230 | 1.96 | 1.44 | 623 | .02 | 491 |
| Low | A3-6994 | Stream | 6,994 | RA | 68.9 | | | 1,220 | | | | | 526 |
| Low | A3-7049 | Inflow | 7,049 | FA | 6.37 | 3.71 | 18.7 | 9,570 | .04 | 24.5 | 1,610 | .03 | 9,340 |
| Low | A3-7177 | Stream | 7,177 | UFA | 7.09 | 2.79 | 10.1 | 1,200 | 1.98 | .97 | 550 | .04 | 518 |
| Low | A3-7177 | Stream | 7,177 | FA | 34.8 | 1.31 | 10.8 | 1,260 | 2.19 | .96 | 606 | .03 | 488 |
| Low | A3-7177 | Stream | 7,177 | RA | 61.9 | 1.83 | 9.43 | 1,240 | 2.05 | .84 | 555 | .03 | 550 |
| Low | A3-7201 | Inflow | 7,201 | FA | 18.2 | 1.43 | 1.96 | 206 | 4.49 | .23 | 415 | .04 | 39.4 |
| Low | A3-7201 | Inflow | 7,201 | RA | 24.4 | 1.36 | 1.60 | 2.99 | 4.20 | .13 | 426 | .04 | 27.3 |
| Low | A3-7306 | Stream | 7,306 | UFA | 13.7 | 4.63 | 9.90 | 1,420 | 2.07 | 3.18 | 613 | .04 | 669 |
| Low | A3-7306 | Stream | 7,306 | FA | 36.9 | 2.18 | 8.50 | 1,450 | 2.09 | 2.43 | 615 | .02 | 573 |
| Low | A3-7306 | Stream | 7,306 | RA | 61.5 | 1.70 | 8.50 | 1,410 | 1.84 | 1.02 | 567 | .03 | 622 |
| Low | A3-7585 | Stream | 7,585 | UFA | 9.64 | 4.50 | 11.1 | 1,340 | 2.25 | 1.05 | 598 | .05 | 623 |
| Low | A3-7585 | Stream | 7,585 | FA | 31.2 | 1.64 | 4.11 | 1,380 | 1.96 | 1.02 | 574 | .02 | 561 |
| Low | A3-7585 | Stream | 7,585 | RA | 60.5 | 1.76 | 8.56 | 1,370 | 2.03 | .96 | 630 | .03 | 608 |
| Low | A3-7750 | Inflow | 7,750 | UFA | 183 | 3.35 | 46.3 | 73,500 | .24 | 28.7 | 4,350 | .06 | 4,780 |
| Low | A3-7750 | Inflow | 7,750 | FA | 184 | 2.99 | 39.6 | 73,300 | .19 | 25.8 | 3,960 | .03 | 7,370 |
| Low | A3-7750 | Inflow | 7,750 | RA | 267 | 3.66 | 46.4 | 75,100 | .19 | 27.0 | 4,130 | .01 | 7,820 |
| Low | A3-7858 | Stream | 7,858 | UFA | 1.78 | .41 | 10.6 | 1,390 | 1.80 | 1.40 | 555 | .02 | 606 |
| Low | A3-7858 | Stream | 7,858 | FA | 31.0 | 1.37 | 8.27 | 1,390 | 1.78 | 1.34 | 537 | .02 | 568 |
| Low | A3-7858 | Stream | 7,858 | RA | 64.6 | 1.62 | 9.21 | 1,530 | 1.99 | .96 | 573 | .03 | 625 |
| High | A3HF-4023 | Stream | 3,909 | FU | | | | | | | | | |
| High | A3HF-4161 | Inflow | 4,033 | FU | | | | | | | | | |
| High | A3HF-4166 | Stream | 4,166 | FU | | | | | | | | | |

Table S1. Chemical analyses of low- and high-flow synoptic samples, Animas River from Arrastra Creek to Silverton, August 2002 and April 2003. Colorado

| Study | Sample identification | Source | Distance | Filter | Iron | Lead | Lithium | Manganese | Molybdenum | Nickel | Strontium | Vanadiaum | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | meters | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| High | A3HF-4186 | Inflow | 4,186 | FU | | | | | | | | | |
| High | A3HF-4250 | Stream | 4,250 | FU | | | | | | | | | |
| High | A3HF-4385 | Inflow | 4,385 | FU | | | | | | | | | |
| High | A3HF-WP142 | Inflow | 4,533 | FU | | | | | | | | | |
| High | A3HF-4580 | Inflow | 4,586 | FU | | | | | | | | | |
| High | A3HF-4892 | Inflow | 4,886 | FU | | | | | | | | | |
| High | A3HF-4916 | Stream | 4,916 | FU | | | | | | | | | |
| High | A3HF-4951 | Inflow | 4,951 | FU | | | | | | | | | |
| High | A3HF-5038 | Inflow | 5,038 | FU | | | | | | | | | |
| High | A3HF-5221 | Inflow | 5,221 | FU | | | | | | | | | |
| High | A3HF-5356 | Inflow | 5,356 | FU | | | | | | | | | |
| High | A3HF-5536 | Stream | 5,536 | FU | | | | | | | | | |
| High | A3HF-5855 | Inflow | 5,858 | FU | | | | | | | | | |
| High | A3HF-6150 | Inflow | 6,150 | FU | | | | | | | | | |
| High | A3HF-6745 | Stream | 6,745 | FU | | | | | | | | | |
| High | A3HF-7100 | Inflow | 7,201 | FU | | | | | | | | | |
| High | A3HF-7306 | Stream | 7,306 | FU | | | | | | | | | |
| High | A3HF-7750 | Inflow | 7,750 | FU | | | | | | | | | |
| High | A3HF-7858A | Stream | 7,858 | FU | | | | | | | | | |
| High | A3HF-7858B | Stream | 7,858 | FU | | | | | | | | | |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Discharge | Calcium | Magnesium | Sodium | Potassium | Sulfate | Chloride | Bromide | Sulfate, ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | L/s | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| AMIN-4166 | 4166 | 4/16/03 13:00 | FA | 1,289 | 45.3 | 2.79 | 2.21 | .59 | 92.8 | 1.34 | 1.29 | 94.5 |
| AMIN-4166 | 4166 | 4/16/03 13:00 | RA | 1,289 | 41.6 | 2.69 | 2.31 | .60 | 92.8 | 1.34 | 1.29 | 82.4 |
| AMIN-4166 | 4166 | 4/16/03 14:00 | FA | 1,423 | 42.6 | 2.81 | 2.34 | .57 | 92.8 | 1.30 | 1.17 | 89.6 |
| AMIN-4166 | 4166 | 4/16/03 14:00 | RA | 1,423 | 41.1 | 2.69 | 2.24 | .57 | 92.8 | 1.30 | 1.17 | 84.0 |
| AMIN-4166 | 4166 | 4/16/03 15:00 | FA | 1,473 | 40.2 | 2.75 | 2.22 | .57 | 94.8 | 1.25 | 1.13 | 85.6 |
| AMIN-4166 | 4166 | 4/16/03 15:00 | RA | 1,473 | 41.8 | 2.80 | 2.21 | .60 | 94.8 | 1.25 | 1.13 | 90.3 |
| AMIN-4166 | 4166 | 4/16/03 16:00 | FA | 1,508 | 40.6 | 2.67 | 2.18 | .57 | 99.3 | 1.28 | 1.10 | 87.4 |
| AMIN-4166 | 4166 | 4/16/03 16:00 | RA | 1,508 | 42.1 | 2.78 | 2.17 | .60 | 99.3 | 1.28 | 1.10 | 87.7 |
| AMIN-4166 | 4166 | 4/17/03 8:37 | FA | 1,316 | 43.1 | 2.74 | 2.33 | .55 | 95.4 | 1.30 | 1.26 | 87.7 |
| AMIN-4166 | 4166 | 4/17/03 8:37 | RA | 1,316 | 44.1 | 2.73 | 2.32 | .58 | 95.4 | 1.30 | 1.26 | 86.4 |
| AMIN-4166 | 4166 | 4/17/03 9:48 | FA | 1,289 | 42.7 | 2.71 | 2.31 | .53 | 96.4 | 1.31 | 1.29 | 85.6 |
| AMIN-4166 | 4166 | 4/17/03 9:48 | RA | 1,289 | 43.8 | 2.85 | 2.33 | .52 | 96.4 | 1.31 | 1.29 | 89.1 |
| AMIN-4166 | 4166 | 4/17/03 11:01 | FA | 1,287 | 42.7 | 2.87 | 2.35 | .49 | 96.5 | 1.37 | 1.29 | 90.0 |
| AMIN-4166 | 4166 | 4/17/03 11:01 | RA | 1,287 | 42.6 | 2.65 | 2.28 | .53 | 96.5 | 1.37 | 1.29 | 85.5 |
| AMIN-4166 | 4166 | 4/17/03 11:59 | FA | 1,336 | 43.3 | 2.68 | 2.26 | .51 | 97.7 | 1.34 | 1.24 | 88.0 |
| AMIN-4166 | 4166 | 4/17/03 11:59 | RA | 1,336 | 43.2 | 2.75 | 2.30 | .51 | 97.7 | 1.34 | 1.24 | 90.2 |
| AMIN-4166 | 4166 | 4/17/03 13:55 | FA | 1,405 | 40.9 | 2.60 | 2.15 | .53 | 96.4 | 1.22 | 1.19 | 83.3 |
| AMIN-4166 | 4166 | 4/17/03 13:55 | RA | 1,405 | 42.1 | 2.69 | 2.19 | .52 | 96.4 | 1.22 | 1.19 | 89.1 |
| AMIN-4916 | 4916 | 4/16/03 13:00 | FA | 1,348 | 41.9 | 2.66 | 2.29 | .57 | 96.1 | 1.30 | 1.23 | 87.6 |
| AMIN-4916 | 4916 | 4/16/03 13:00 | RA | 1,348 | 41.5 | 2.79 | 2.29 | .56 | 96.1 | 1.30 | 1.23 | 90.1 |
| AMIN-4916 | 4916 | 4/16/03 14:00 | FA | 1,501 | 40.5 | 2.65 | 2.17 | .54 | 97.9 | 1.22 | .88 | 88.8 |
| AMIN-4916 | 4916 | 4/16/03 14:00 | RA | 1,501 | 42.0 | 2.81 | 2.26 | .59 | 97.9 | 1.22 | .88 | 90.5 |
| AMIN-4916 | 4916 | 4/16/03 16:00 | FA | 1,638 | 40.4 | 2.76 | 2.20 | .57 | 94.9 | 1.27 | 1.01 | 89.8 |
| AMIN-4916 | 4916 | 4/16/03 16:00 | RA | 1,638 | 41.6 | 2.76 | 2.16 | .55 | 94.9 | 1.27 | 1.01 | 87.1 |
| AMIN-4916 | 4916 | 4/16/03 17:00 | FA | 1,721 | 41.3 | 2.74 | 2.18 | .57 | 95.7 | 1.29 | .96 | 87.8 |
| AMIN-4916 | 4916 | 4/16/03 17:00 | RA | 1,721 | 41.5 | 2.66 | 2.17 | .55 | 95.7 | 1.29 | .96 | 82.6 |
| AMIN-4916 | 4916 | 4/16/03 18:00 | FA | 1,748 | 39.5 | 2.69 | 2.14 | .57 | 93.1 | 1.23 | .95 | 87.8 |
| AMIN-4916 | 4916 | 4/16/03 18:00 | RA | 1,748 | 41.6 | 2.67 | 2.15 | .53 | 93.1 | 1.23 | .95 | 85.2 |
| AMIN-4916 | 4916 | 4/16/03 19:00 | FA | 1,782 | 41.6 | 2.69 | 2.20 | .55 | 93.5 | 1.29 | .93 | 86.9 |
| AMIN-4916 | 4916 | 4/16/03 19:00 | RA | 1,782 | 40.7 | 2.73 | 2.07 | .60 | 93.5 | 1.29 | .93 | 87.3 |
| AMIN-4916 | 4916 | 4/16/03 20:00 | FA | 1,705 | 39.9 | 2.59 | 2.09 | .58 | 93.4 | 1.23 | .97 | 83.7 |
| AMIN-4916 | 4916 | 4/16/03 20:00 | RA | 1,705 | 40.7 | 2.68 | 2.10 | .59 | 93.4 | 1.23 | .97 | 84.8 |
| AMIN-4916 | 4916 | 4/16/03 21:00 | FA | 1,689 | 40.6 | 2.60 | 2.10 | .58 | 94.4 | 1.26 | .98 | 83.1 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Discharge | Calcium | Magnesium | Sodium | Potassium | Sulfate | Chloride | Bromide | Sulfate, ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | L/s | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| AMIN-4916 | 4916 | 4/16/03 21:00 | RA | 1,689 | 41.0 | 2.67 | 2.15 | .54 | 94.4 | 1.26 | .98 | 86.8 |
| AMIN-4916 | 4916 | 4/16/03 22:00 | FA | 1,638 | 41.5 | 2.71 | 2.20 | .59 | 90.3 | 1.23 | .98 | 89.1 |
| AMIN-4916 | 4916 | 4/16/03 22:00 | RA | 1,638 | 41.3 | 2.68 | 2.12 | .54 | 90.3 | 1.23 | .98 | 85.5 |
| AMIN-4916 | 4916 | 4/16/03 23:00 | FA | 1,562 | 41.1 | 2.65 | 2.15 | .57 | 93.8 | 1.23 | 1.03 | 85.2 |
| AMIN-4916 | 4916 | 4/16/03 23:00 | RA | 1,562 | 41.1 | 2.70 | 2.18 | .54 | 93.8 | 1.23 | 1.03 | 85.8 |
| AMIN-4916 | 4916 | 4/17/03 0:00 | FA | 1,638 | 40.5 | 2.69 | 2.14 | .52 | 90.8 | 1.19 | .98 | 86.7 |
| AMIN-4916 | 4916 | 4/17/03 0:00 | RA | 1,638 | 41.3 | 2.62 | 2.18 | .53 | 90.8 | 1.19 | .98 | 85.5 |
| AMIN-4916 | 4916 | 4/17/03 1:00 | FA | 1,582 | 42.1 | 2.68 | 2.22 | .56 | 94.1 | 1.12 | 1.04 | 87.2 |
| AMIN-4916 | 4916 | 4/17/03 1:00 | RA | 1,582 | 40.2 | 2.68 | 2.16 | .50 | 94.1 | 1.12 | 1.04 | 86.8 |
| AMIN-4916 | 4916 | 4/17/03 8:50 | FA | 1,396 | 44.2 | 2.78 | 2.31 | .49 | 98.4 | 1.27 | 1.19 | 88.9 |
| AMIN-4916 | 4916 | 4/17/03 8:50 | RA | 1,396 | 43.6 | 2.78 | 2.32 | .55 | 98.4 | 1.27 | 1.19 | 88.8 |
| AMIN-4916 | 4916 | 4/17/03 9:57 | FA | 1,358 | 43.2 | 2.82 | 2.31 | .51 | 99.0 | 1.27 | 1.22 | 90.8 |
| AMIN-4916 | 4916 | 4/17/03 9:57 | RA | 1,358 | 44.2 | 2.86 | 2.37 | .54 | 99.0 | 1.27 | 1.22 | 90.8 |
| AMIN-4916 | 4916 | 4/17/03 11:08 | FA | 1,388 | 43.6 | 2.74 | 2.32 | .55 | 99.1 | 1.32 | 1.20 | 89.4 |
| AMIN-4916 | 4916 | 4/17/03 11:08 | RA | 1,388 | 45.3 | 2.90 | 2.38 | .53 | 99.1 | 1.32 | 1.20 | 94.0 |
| AMIN-4916 | 4916 | 4/17/03 12:06 | FA | 1,399 | 41.9 | 2.67 | 2.25 | .49 | 99.9 | 1.32 | 1.19 | 86.8 |
| AMIN-4916 | 4916 | 4/17/03 12:06 | RA | 1,399 | 43.4 | 2.76 | 2.34 | .53 | 99.9 | 1.32 | 1.19 | 92.0 |
| AMIN-4916 | 4916 | 4/17/03 14:02 | FA | 1,552 | 41.5 | 2.76 | 2.25 | .59 | 99.7 | 1.24 | 1.07 | 88.7 |
| AMIN-4916 | 4916 | 4/17/03 14:02 | RA | 1,552 | 42.7 | 2.73 | 2.23 | .56 | 99.7 | 1.24 | 1.07 | 87.7 |
| AMIN-5536 | 5536 | 4/16/03 13:00 | FA | 1,351 | 41.7 | 2.72 | 2.25 | .54 | 100 | 1.32 | 1.16 | 87.7 |
| AMIN-5536 | 5536 | 4/16/03 13:00 | RA | 1,351 | 43.7 | 2.82 | 2.34 | .58 | 100 | 1.32 | 1.16 | 95.1 |
| AMIN-5536 | 5536 | 4/16/03 14:00 | FA | 1,294 | 44.8 | 2.79 | 2.31 | .52 | 102 | 1.46 | 1.28 | 94.1 |
| AMIN-5536 | 5536 | 4/16/03 14:00 | RA | 1,294 | 43.0 | 2.76 | 2.23 | .61 | 102 | 1.46 | 1.28 | 91.5 |
| AMIN-5536 | 5536 | 4/16/03 15:00 | FA | 1,658 | 42.1 | 2.69 | 2.20 | .53 | 101 | 1.22 | 1.00 | 89.3 |
| AMIN-5536 | 5536 | 4/16/03 15:00 | RA | 1,658 | 42.1 | 2.71 | 2.20 | .64 | 101 | 1.22 | 1.00 | 91.4 |
| AMIN-5536 | 5536 | 4/16/03 16:00 | FA | 1,686 | 42.2 | 2.69 | 2.15 | .57 | 99.4 | 1.25 | .98 | 92.1 |
| AMIN-5536 | 5536 | 4/16/03 16:00 | RA | 1,686 | 42.0 | 2.71 | 2.14 | .65 | 99.4 | 1.25 | .98 | 92.5 |
| AMIN-5536 | 5536 | 4/16/03 17:00 | FA | 1,765 | 41.0 | 2.65 | 2.09 | .52 | 97.5 | 1.19 | .94 | 89.6 |
| AMIN-5536 | 5536 | 4/16/03 17:00 | RA | 1,765 | 40.7 | 2.67 | 2.12 | .57 | 97.5 | 1.19 | .94 | 90.0 |
| AMIN-5536 | 5536 | 4/16/03 18:00 | FA | 1,794 | 39.6 | 2.61 | 2.10 | .54 | 97.3 | 1.29 | .93 | 87.8 |
| AMIN-5536 | 5536 | 4/16/03 18:00 | RA | 1,794 | 42.8 | 2.78 | 2.20 | .61 | 97.3 | 1.29 | .93 | 91.2 |
| AMIN-5536 | 5536 | 4/16/03 19:00 | FA | 1,870 | 38.9 | 2.56 | 2.04 | .52 | 93.6 | 1.25 | .89 | 84.8 |
| AMIN-5536 | 5536 | 4/16/03 19:00 | RA | 1,870 | 41.0 | 2.62 | 2.07 | .59 | 93.6 | 1.25 | .89 | 86.6 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Discharge | Calcium | Magnesium | Sodium | Potassium | Sulfate | Chloride | Bromide | Sulfate, ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | L/s | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| AMIN-5536 | 5536 | 4/16/03 20:00 | FA | 1,815 | 40.0 | 2.58 | 2.12 | .55 | 96.2 | 1.24 | .91 | 84.7 |
| AMIN-5536 | 5536 | 4/16/03 20:00 | RA | 1,815 | 40.5 | 2.64 | 2.06 | .59 | 96.2 | 1.24 | .91 | 87.8 |
| AMIN-5536 | 5536 | 4/16/03 21:00 | FA | 1,716 | 41.3 | 2.71 | 2.11 | .55 | 98.5 | 1.24 | .97 | 88.5 |
| AMIN-5536 | 5536 | 4/16/03 21:00 | RA | 1,716 | 41.5 | 2.71 | 2.13 | .65 | 98.5 | 1.24 | .97 | 88.9 |
| AMIN-5536 | 5536 | 4/16/03 22:00 | FA | 1,754 | 41.0 | 2.63 | 2.10 | .55 | 96.9 | 1.23 | .95 | 87.6 |
| AMIN-5536 | 5536 | 4/16/03 22:00 | RA | 1,754 | 42.4 | 2.70 | 2.14 | .57 | 96.9 | 1.23 | .95 | 89.9 |
| AMIN-5536 | 5536 | 4/16/03 23:00 | FA | 1,714 | 41.0 | 2.73 | 2.14 | .53 | 97.4 | 1.24 | .97 | 89.9 |
| AMIN-5536 | 5536 | 4/16/03 23:00 | RA | 1,714 | 41.2 | 2.73 | 2.14 | .65 | 97.4 | 1.24 | .97 | 90.4 |
| AMIN-5536 | 5536 | 4/17/03 0:00 | FA | 1,705 | 41.5 | 2.74 | 2.10 | .56 | 100 | 1.30 | .97 | 89.4 |
| AMIN-5536 | 5536 | 4/17/03 0:00 | RA | 1,705 | 42.7 | 2.74 | 2.19 | .53 | 100 | 1.30 | .97 | 91.2 |
| AMIN-5536 | 5536 | 4/17/03 1:00 | FA | 1,679 | 40.9 | 2.63 | 2.10 | .57 | 101 | 1.29 | .99 | 87.4 |
| AMIN-5536 | 5536 | 4/17/03 1:00 | RA | 1,679 | 42.3 | 2.74 | 2.15 | .53 | 101 | 1.29 | .99 | 88.4 |
| AMIN-5536 | 5536 | 4/17/03 9:06 | FA | 1,516 | 44.4 | 2.81 | 2.25 | .52 | 101 | 1.29 | 1.09 | 95.2 |
| AMIN-5536 | 5536 | 4/17/03 9:06 | RA | 1,516 | 44.7 | 2.82 | 2.30 | .51 | 101 | 1.29 | 1.09 | 93.9 |
| AMIN-5536 | 5536 | 4/17/03 10:07 | FA | 1,503 | 43.3 | 2.63 | 2.18 | .52 | 102 | 1.23 | 1.13 | 88.2 |
| AMIN-5536 | 5536 | 4/17/03 10:07 | RA | 1,503 | 44.1 | 2.82 | 2.27 | .51 | 102 | 1.23 | 1.13 | 94.8 |
| AMIN-5536 | 5536 | 4/17/03 11:13 | FA | 1,515 | 45.0 | 2.92 | 2.34 | .53 | 103 | 1.28 | 1.10 | 97.3 |
| AMIN-5536 | 5536 | 4/17/03 11:13 | RA | 1,515 | 44.0 | 2.77 | 2.25 | .54 | 103 | 1.28 | 1.10 | 94.9 |
| AMIN-5536 | 5536 | 4/17/03 12:14 | FA | 1,439 | 51.9 | 2.74 | 2.25 | .48 | 103 | 1.21 | 1.15 | 88.6 |
| AMIN-5536 | 5536 | 4/17/03 12:14 | RA | 1,439 | 46.8 | 2.93 | 2.35 | .53 | 103 | 1.21 | 1.15 | 98.4 |
| AMIN-5536 | 5536 | 4/17/03 14:10 | FA | 1,620 | 43.5 | 2.73 | 2.27 | .55 | 102 | 1.15 | 1.02 | 91.5 |
| AMIN-5536 | 5536 | 4/17/03 14:10 | RA | 1,620 | 44.6 | 2.76 | 2.24 | .54 | 102 | 1.15 | 1.02 | 90.9 |
| AMIN-6745 | 6745 | 4/16/03 13:00 | FA | 1,358 | 45.2 | 2.75 | 2.33 | .53 | 108 | 1.37 | 1.22 | 99.8 |
| AMIN-6745 | 6745 | 4/16/03 13:00 | RA | 1,358 | 47.8 | 2.94 | 2.45 | .56 | 108 | 1.37 | 1.22 | 101 |
| AMIN-6745 | 6745 | 4/16/03 14:00 | FA | 1,462 | 46.7 | 2.78 | 2.31 | .64 | 107 | 1.23 | 1.13 | 97.7 |
| AMIN-6745 | 6745 | 4/16/03 14:00 | RA | 1,462 | 45.5 | 2.90 | 2.34 | .57 | 107 | 1.23 | 1.13 | 100 |
| AMIN-6745 | 6745 | 4/16/03 15:00 | FA | 1,711 | 45.4 | 2.76 | 2.29 | .59 | 105 | 1.20 | .97 | 95.9 |
| AMIN-6745 | 6745 | 4/16/03 15:00 | RA | 1,711 | 44.7 | 2.79 | 2.27 | .51 | 105 | 1.20 | .97 | 98.8 |
| AMIN-6745 | 6745 | 4/16/03 16:00 | FA | 1,817 | 43.9 | 2.69 | 2.12 | .62 | 105 | 1.37 | 1.14 | 94.0 |
| AMIN-6745 | 6745 | 4/16/03 16:00 | RA | 1,817 | 42.0 | 2.74 | 2.15 | .54 | 105 | 1.37 | 1.14 | 95.2 |
| AMIN-6745 | 6745 | 4/16/03 17:00 | FA | 1,819 | 45.2 | 2.82 | 2.19 | .60 | 103 | 1.19 | .91 | 96.3 |
| AMIN-6745 | 6745 | 4/16/03 17:00 | RA | 1,819 | 42.4 | 2.86 | 2.20 | .67 | 103 | 1.19 | .91 | 97.0 |
| AMIN-6745 | 6745 | 4/16/03 18:00 | FA | 1,927 | 45.1 | 2.86 | 2.23 | .57 | 103 | 1.18 | .86 | 98.3 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Discharge | Calcium | Magnesium | Sodium | Potassium | Sulfate | Chloride | Bromide | Sulfate, ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | L/s | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| AMIN-6745 | 6745 | 4/16/03 18:00 | RA | 1,927 | 45.1 | 2.88 | 2.23 | .67 | 103 | 1.18 | .86 | 97.3 |
| AMIN-6745 | 6745 | 4/16/03 19:00 | FA | 1,892 | 42.8 | 2.71 | 2.15 | .61 | 102 | 1.22 | .88 | 94.4 |
| AMIN-6745 | 6745 | 4/16/03 19:00 | RA | 1,892 | 43.1 | 2.77 | 2.14 | .57 | 102 | 1.22 | .88 | 97.4 |
| AMIN-6745 | 6745 | 4/16/03 20:00 | FA | 1,952 | 43.4 | 2.75 | 2.14 | .61 | 102 | 1.18 | .85 | 95.5 |
| AMIN-6745 | 6745 | 4/16/03 20:00 | RA | 1,952 | 43.6 | 2.72 | 2.15 | .59 | 102 | 1.18 | .85 | 93.3 |
| AMIN-6745 | 6745 | 4/16/03 21:00 | FA | 1,872 | 44.7 | 2.84 | 2.22 | .66 | 102 | 1.21 | .89 | 98.0 |
| AMIN-6745 | 6745 | 4/16/03 21:00 | RA | 1,872 | 44.3 | 2.73 | 2.19 | .63 | 102 | 1.21 | .89 | 95.5 |
| AMIN-6745 | 6745 | 4/16/03 22:00 | FA | 1,879 | 43.3 | 2.82 | 2.14 | .63 | 101 | 1.16 | .88 | 93.7 |
| AMIN-6745 | 6745 | 4/16/03 22:00 | RA | 1,879 | 42.6 | 2.70 | 2.15 | .60 | 101 | 1.16 | .88 | 96.3 |
| AMIN-6745 | 6745 | 4/16/03 23:00 | FA | 1,819 | 42.5 | 2.68 | 2.12 | .63 | 102 | 1.20 | .91 | 93.4 |
| AMIN-6745 | 6745 | 4/16/03 23:00 | RA | 1,819 | 42.4 | 2.65 | 2.18 | .56 | 102 | 1.20 | .91 | 91.9 |
| AMIN-6745 | 6745 | 4/17/03 0:00 | FA | 1,774 | 43.8 | 2.71 | 2.16 | .61 | 103 | 1.17 | .94 | 92.9 |
| AMIN-6745 | 6745 | 4/17/03 0:00 | RA | 1,774 | 43.7 | 2.77 | 2.15 | .62 | 103 | 1.17 | .94 | 96.0 |
| AMIN-6745 | 6745 | 4/17/03 1:00 | FA | 1,786 | 42.7 | 2.67 | 2.10 | .60 | 104 | 1.22 | .93 | 91.2 |
| AMIN-6745 | 6745 | 4/17/03 1:00 | RA | 1,786 | 43.9 | 2.87 | 2.23 | .65 | 104 | 1.22 | .93 | 96.4 |
| AMIN-6745 | 6745 | 4/17/03 2:00 | FA | 1,776 | 43.2 | 2.71 | 2.15 | .56 | 103 | 1.20 | .93 | 92.8 |
| AMIN-6745 | 6745 | 4/17/03 2:00 | RA | 1,776 | 41.4 | 2.68 | 2.14 | .54 | 103 | 1.20 | .93 | 91.8 |
| AMIN-6745 | 6745 | 4/17/03 3:00 | FA | 1,757 | 44.7 | 2.72 | 2.10 | .58 | 104 | 1.20 | .94 | 92.1 |
| AMIN-6745 | 6745 | 4/17/03 3:00 | RA | 1,757 | 43.7 | 2.73 | 2.13 | .52 | 104 | 1.20 | .94 | 96.4 |
| AMIN-6745 | 6745 | 4/17/03 4:00 | FA | 1,717 | 44.2 | 2.85 | 2.20 | .57 | 103 | 1.20 | .97 | 95.8 |
| AMIN-6745 | 6745 | 4/17/03 4:00 | RA | 1,717 | 43.6 | 2.74 | 2.15 | .58 | 103 | 1.20 | .97 | 97.4 |
| AMIN-6745 | 6745 | 4/17/03 5:00 | FA | 1,739 | 45.1 | 2.80 | 2.24 | .58 | 104 | 1.24 | .95 | 95.0 |
| AMIN-6745 | 6745 | 4/17/03 5:00 | RA | 1,739 | 43.8 | 2.73 | 2.21 | .56 | 104 | 1.24 | .95 | 96.9 |
| AMIN-6745 | 6745 | 4/17/03 6:00 | FA | 1,721 | 43.4 | 2.67 | 2.15 | .54 | 103 | 1.17 | .96 | 92.5 |
| AMIN-6745 | 6745 | 4/17/03 6:00 | RA | 1,721 | 43.7 | 2.75 | 2.20 | .58 | 103 | 1.17 | .96 | 97.4 |
| AMIN-6745 | 6745 | 4/17/03 7:00 | FA | 1,659 | 45.6 | 2.84 | 2.26 | .54 | 104 | 1.35 | 1.18 | 99.0 |
| AMIN-6745 | 6745 | 4/17/03 7:00 | RA | 1,659 | 43.9 | 2.75 | 2.16 | .53 | 104 | 1.35 | 1.18 | 96.3 |
| AMIN-6745 | 6745 | 4/17/03 9:17 | FA | 1,549 | 47.0 | 2.96 | 2.31 | .60 | 109 | 1.19 | 1.07 | 100 |
| AMIN-6745 | 6745 | 4/17/03 9:17 | RA | 1,549 | 45.7 | 2.76 | 2.22 | .53 | 109 | 1.19 | 1.07 | 94.3 |
| AMIN-6745 | 6745 | 4/17/03 10:16 | FA | 1,533 | 47.1 | 2.92 | 2.34 | .55 | 110 | 1.38 | 1.23 | 101 |
| AMIN-6745 | 6745 | 4/17/03 10:16 | RA | 1,533 | 47.2 | 2.89 | 2.38 | .59 | 110 | 1.38 | 1.23 | 99.4 |
| AMIN-6745 | 6745 | 4/17/03 11:23 | FA | 1,517 | 46.9 | 3.00 | 2.38 | .56 | 109 | 1.32 | 1.09 | 102 |
| AMIN-6745 | 6745 | 4/17/03 11:23 | RA | 1,517 | 46.7 | 2.99 | 2.30 | .54 | 109 | 1.32 | 1.09 | 102 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Discharge | Calcium | Magnesium | Sodium | Potassium | Sulfate | Chloride | Bromide | Sulfate, ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | L/s | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| AMIN-6745 | 6745 | 4/17/03 12:20 | FA | 1,491 | 46.5 | 2.88 | 2.34 | .54 | 110 | 1.34 | 1.11 | 101 |
| AMIN-6745 | 6745 | 4/17/03 12:20 | RA | 1,491 | 48.0 | 2.98 | 2.38 | .57 | 110 | 1.34 | 1.11 | 105 |
| AMIN-6745 | 6745 | 4/17/03 14:16 | FA | 1,751 | 46.3 | 2.80 | 2.31 | .58 | 110 | 1.29 | .95 | 99.9 |
| AMIN-6745 | 6745 | 4/17/03 14:16 | RA | 1,751 | 46.1 | 2.81 | 2.22 | .53 | 110 | 1.29 | .95 | 100 |
| AMIN-7306 | 7306 | 4/16/03 13:00 | FA | 1,430 | 46.7 | 2.89 | 2.42 | .60 | 107 | 1.07 | 1.16 | 103 |
| AMIN-7306 | 7306 | 4/16/03 13:00 | RA | 1,430 | 44.9 | 2.91 | 2.34 | .62 | 107 | 1.07 | 1.16 | 99.7 |
| AMIN-7306 | 7306 | 4/16/03 14:00 | FA | 1,444 | 47.3 | 2.89 | 2.42 | .54 | 109 | 1.31 | 1.17 | 99.7 |
| AMIN-7306 | 7306 | 4/16/03 14:00 | RA | 1,444 | 46.7 | 2.91 | 2.41 | .57 | 109 | 1.31 | 1.17 | 99.2 |
| AMIN-7306 | 7306 | 4/16/03 15:00 | FA | 1,708 | 47.6 | 2.89 | 2.33 | .60 | 108 | 1.28 | .80 | 100 |
| AMIN-7306 | 7306 | 4/16/03 15:00 | RA | 1,708 | 46.0 | 2.84 | 2.26 | .58 | 108 | 1.28 | .80 | 101 |
| AMIN-7306 | 7306 | 4/16/03 16:00 | FA | 1,827 | 44.3 | 2.75 | 2.23 | .55 | 107 | 1.17 | .95 | 96.4 |
| AMIN-7306 | 7306 | 4/16/03 16:00 | RA | 1,827 | 46.7 | 2.86 | 2.28 | .63 | 107 | 1.17 | .95 | 100 |
| AMIN-7306 | 7306 | 4/16/03 17:00 | FA | 1,860 | 43.6 | 2.77 | 2.22 | .57 | 107 | 1.36 | 1.15 | 94.8 |
| AMIN-7306 | 7306 | 4/16/03 17:00 | RA | 1,860 | 42.8 | 2.76 | 2.17 | .62 | 107 | 1.36 | 1.15 | 96.7 |
| AMIN-7306 | 7306 | 4/16/03 18:00 | FA | 1,905 | 43.7 | 2.80 | 2.17 | .60 | 106 | 1.31 | 1.06 | 97.5 |
| AMIN-7306 | 7306 | 4/16/03 18:00 | RA | 1,905 | 41.4 | 2.73 | 2.10 | .57 | 106 | 1.31 | 1.06 | 94.3 |
| AMIN-7306 | 7306 | 4/16/03 19:00 | FA | 2,013 | 42.4 | 2.72 | 2.14 | .63 | 103 | 1.23 | .86 | 93.6 |
| AMIN-7306 | 7306 | 4/16/03 19:00 | RA | 2,013 | 42.9 | 2.73 | 2.14 | .58 | 103 | 1.23 | .86 | 95.8 |
| AMIN-7306 | 7306 | 4/16/03 20:00 | FA | 2,038 | 42.7 | 2.72 | 2.13 | .62 | 105 | 1.18 | .86 | 94.0 |
| AMIN-7306 | 7306 | 4/16/03 20:00 | RA | 2,038 | 43.1 | 2.78 | 2.16 | .58 | 105 | 1.18 | .86 | 97.8 |
| AMIN-7306 | 7306 | 4/16/03 21:00 | FA | 1,898 | 43.2 | 2.74 | 2.19 | .62 | 104 | 1.16 | .89 | 96.9 |
| AMIN-7306 | 7306 | 4/16/03 21:00 | RA | 1,898 | 44.0 | 2.76 | 2.14 | .63 | 104 | 1.16 | .89 | 96.1 |
| AMIN-7306 | 7306 | 4/16/03 22:00 | FA | 1,890 | 43.7 | 2.78 | 2.21 | .62 | 104 | 1.19 | .89 | 95.7 |
| AMIN-7306 | 7306 | 4/16/03 22:00 | RA | 1,890 | 43.3 | 2.77 | 2.16 | .59 | 104 | 1.19 | .89 | 94.4 |
| AMIN-7306 | 7306 | 4/16/03 23:00 | FA | 1,821 | 45.4 | 2.90 | 2.24 | .60 | 106 | 1.28 | .92 | 98.7 |
| AMIN-7306 | 7306 | 4/16/03 23:00 | RA | 1,821 | 43.9 | 2.73 | 2.15 | .59 | 106 | 1.28 | .92 | 95.0 |
| AMIN-7306 | 7306 | 4/17/03 0:00 | FA | 1,800 | 44.8 | 2.87 | 2.19 | .63 | 106 | 1.40 | 1.15 | 96.6 |
| AMIN-7306 | 7306 | 4/17/03 0:00 | RA | 1,800 | 44.0 | 2.78 | 2.18 | .57 | 106 | 1.40 | 1.15 | 97.6 |
| AMIN-7306 | 7306 | 4/17/03 9:23 | FA | 1,569 | 45.7 | 2.87 | 2.23 | .57 | 110 | 1.27 | 1.06 | 100 |
| AMIN-7306 | 7306 | 4/17/03 9:23 | RA | 1,569 | 46.6 | 2.86 | 2.31 | .55 | 110 | 1.27 | 1.06 | 100 |
| AMIN-7306 | 7306 | 4/17/03 10:27 | RA | 1,603 | 46.3 | 3.04 | 2.37 | .57 | 110 | 1.41 | 1.25 | 104 |
| AMIN-7306 | 7306 | 4/17/03 11:29 | FA | 1,510 | 46.7 | 3.05 | 2.35 | .57 | 111 | 1.17 | 1.10 | 107 |
| AMIN-7306 | 7306 | 4/17/03 11:29 | RA | 1,510 | 47.1 | 2.95 | 2.35 | .56 | 111 | 1.17 | 1.10 | 103 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Discharge | Calcium | Magnesium | Sodium | Potassium | Sulfate | Chloride | Bromide | Sulfate, ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | L/s | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| AMIN-7306 | 7306 | 4/17/03 12:26 | FA | 1,539 | 47.2 | 3.08 | 2.36 | .58 | 111 | 1.36 | 1.08 | 105 |
| AMIN-7306 | 7306 | 4/17/03 12:26 | RA | 1,539 | 46.9 | 3.00 | 2.33 | .55 | 111 | 1.36 | 1.08 | 103 |
| AMIN-7306 | 7306 | 4/17/03 14:22 | FA | 1,414 | 46.0 | 2.78 | 2.21 | .57 | 111 | 1.33 | 1.17 | 96.4 |
| AMIN-7306 | 7306 | 4/17/03 14:22 | RA | 1,414 | 47.2 | 2.86 | 2.31 | .54 | 111 | 1.33 | 1.17 | 99.5 |
| AMIN-7858 | 7858 | 4/16/03 13:00 | FA | 1,209 | 47.7 | 2.92 | 2.36 | .64 | 117 | 1.54 | 1.37 | 104 |
| AMIN-7858 | 7858 | 4/16/03 13:00 | RA | 1,209 | 48.8 | 3.00 | 2.40 | .69 | 117 | 1.54 | 1.37 | 110 |
| AMIN-7858 | 7858 | 4/16/03 14:00 | FA | 1,476 | 49.8 | 2.98 | 2.45 | .67 | 118 | 1.49 | 1.12 | 109 |
| AMIN-7858 | 7858 | 4/16/03 14:00 | RA | 1,476 | 48.3 | 3.08 | 2.45 | .68 | 118 | 1.49 | 1.12 | 107 |
| AMIN-7858 | 7858 | 4/16/03 17:00 | FA | 2,021 | 47.5 | 3.01 | 2.28 | .70 | 116 | 1.60 | 1.08 | 107 |
| AMIN-7858 | 7858 | 4/16/03 17:00 | RA | 2,021 | 47.2 | 3.04 | 2.25 | .72 | 116 | 1.60 | 1.08 | 110 |
| AMIN-7858 | 7858 | 4/16/03 18:00 | FA | 1,999 | 45.7 | 2.85 | 2.17 | .66 | 115 | 1.40 | .86 | 100 |
| AMIN-7858 | 7858 | 4/16/03 18:00 | RA | 1,999 | 44.0 | 2.98 | 2.15 | .72 | 115 | 1.40 | .86 | 103 |
| AMIN-7858 | 7858 | 4/16/03 19:00 | FA | 2,108 | 44.3 | 2.81 | 2.15 | .65 | 111 | 1.35 | .82 | 97.9 |
| AMIN-7858 | 7858 | 4/16/03 19:00 | RA | 2,108 | 46.9 | 3.01 | 2.22 | .74 | 111 | 1.35 | .82 | 107 |
| AMIN-7858 | 7858 | 4/16/03 20:00 | FA | 2,063 | 46.4 | 2.91 | 2.19 | .67 | 111 | 1.49 | 1.02 | 101 |
| AMIN-7858 | 7858 | 4/16/03 20:00 | RA | 2,063 | 45.1 | 2.88 | 2.21 | .68 | 111 | 1.49 | 1.02 | 97.6 |
| AMIN-7858 | 7858 | 4/16/03 21:00 | FA | 2,066 | 46.2 | 2.88 | 2.21 | .66 | 111 | 1.31 | .85 | 103 |
| AMIN-7858 | 7858 | 4/16/03 21:00 | RA | 2,066 | 44.5 | 2.92 | 2.15 | .72 | 111 | 1.31 | .85 | 102 |
| AMIN-7858 | 7858 | 4/16/03 22:00 | FA | 1,963 | 45.2 | 2.82 | 2.21 | .66 | 111 | 1.35 | .86 | 97.7 |
| AMIN-7858 | 7858 | 4/16/03 22:00 | RA | 1,963 | 45.2 | 2.96 | 2.15 | .73 | 111 | 1.35 | .86 | 101 |
| AMIN-7858 | 7858 | 4/16/03 23:00 | FA | 1,922 | 45.6 | 2.85 | 2.22 | .63 | 109 | 1.47 | 1.07 | 99.7 |
| AMIN-7858 | 7858 | 4/16/03 23:00 | RA | 1,922 | 47.1 | 2.95 | 2.23 | .70 | 109 | 1.47 | 1.07 | 101 |
| AMIN-7858 | 7858 | 4/17/03 0:00 | FA | 1,879 | 44.2 | 2.82 | 2.08 | .63 | 111 | 1.35 | .90 | 95.1 |
| AMIN-7858 | 7858 | 4/17/03 0:00 | RA | 1,879 | 44.0 | 2.94 | 2.19 | .69 | 111 | 1.35 | .90 | 103 |
| AMIN-7858 | 7858 | 4/17/03 1:00 | FA | 1,866 | 46.2 | 2.87 | 2.22 | .64 | 111 | 1.48 | 1.11 | 99.2 |
| AMIN-7858 | 7858 | 4/17/03 1:00 | RA | 1,866 | 44.4 | 2.88 | 2.17 | .70 | 111 | 1.48 | 1.11 | 100 |
| AMIN-7858 | 7858 | 4/17/03 2:00 | FA | 1,852 | 45.2 | 2.89 | 2.20 | .62 | 111 | 1.28 | .90 | 101 |
| AMIN-7858 | 7858 | 4/17/03 2:00 | RA | 1,852 | 45.5 | 3.05 | 2.26 | .66 | 111 | 1.28 | .90 | 105 |
| AMIN-7858 | 7858 | 4/17/03 3:00 | FA | 1,850 | 47.0 | 3.00 | 2.26 | .62 | 111 | 1.44 | 1.14 | 100 |
| AMIN-7858 | 7858 | 4/17/03 3:00 | RA | 1,850 | 45.8 | 2.96 | 2.18 | .73 | 111 | 1.44 | 1.14 | 103 |
| AMIN-7858 | 7858 | 4/17/03 4:00 | FA | 1,801 | 45.3 | 2.89 | 2.30 | .60 | 111 | 1.43 | 1.13 | 102 |
| AMIN-7858 | 7858 | 4/17/03 4:00 | RA | 1,801 | 43.7 | 2.89 | 2.12 | .67 | 111 | 1.43 | 1.13 | 99.5 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Discharge | Calcium | Magnesium | Sodium | Potassium | Sulfate | Chloride | Bromide | Sulfate, ICP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | L/s | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L | mg/L |
| AMIN-7858 | 7858 | 4/17/03 5:00 | FA | 1,752 | 46.1 | 2.93 | 2.20 | .69 | 111 | 1.40 | .94 | 102 |
| AMIN-7858 | 7858 | 4/17/03 5:00 | RA | 1,752 | 44.1 | 2.89 | 2.18 | .64 | 111 | 1.40 | .94 | 101 |
| AMIN-7858 | 7858 | 4/17/03 6:00 | FA | 1,769 | 45.7 | 2.94 | 2.19 | .67 | 111 | 1.25 | .94 | 103 |
| AMIN-7858 | 7858 | 4/17/03 6:00 | RA | 1,769 | 46.4 | 2.94 | 2.29 | .64 | 111 | 1.25 | .94 | 102 |
| AMIN-7858 | 7858 | 4/17/03 9:23 | FA | 1,388 | 48.5 | 3.06 | 2.32 | .60 | 117 | 1.52 | 1.20 | 109 |
| AMIN-7858 | 7858 | 4/17/03 9:23 | RA | 1,388 | 48.2 | 3.16 | 2.37 | .59 | 117 | 1.52 | 1.20 | 108 |
| AMIN-7858 | 7858 | 4/17/03 10:38 | FA | 1,331 | 48.3 | 3.02 | 2.31 | .60 | 118 | 1.53 | 1.25 | 107 |
| AMIN-7858 | 7858 | 4/17/03 10:38 | RA | 1,331 | 49.6 | 3.18 | 2.45 | .66 | 118 | 1.53 | 1.25 | 109 |
| AMIN-7858 | 7858 | 4/17/03 11:35 | FA | 1,559 | 48.3 | 3.02 | 2.35 | .59 | 117 | 1.37 | 1.06 | 109 |
| AMIN-7858 | 7858 | 4/17/03 11:35 | RA | 1,559 | 47.8 | 3.13 | 2.38 | .60 | 117 | 1.37 | 1.06 | 109 |
| AMIN-7858 | 7858 | 4/17/03 12:45 | FA | 1,612 | 48.6 | 2.97 | 2.37 | .58 | 119 | 1.42 | 1.08 | 110 |
| AMIN-7858 | 7858 | 4/17/03 12:45 | RA | 1,612 | 48.6 | 3.18 | 2.40 | .59 | 119 | 1.42 | 1.08 | 110 |
| AMIN-7858 | 7858 | 4/17/03 14:32 | FA | 1,444 | 47.6 | 2.98 | 2.32 | .63 | 119 | 1.47 | 1.15 | 107 |
| AMIN-7858 | 7858 | 4/17/03 14:32 | RA | 1,444 | 48.6 | 2.96 | 2.36 | .61 | 119 | 1.47 | 1.15 | 111 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Lithium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | mg/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-4166 | 4166 | 4/16/03 13:00 | FA | 6.26 | 70.3 | .19 | 24.9 | .89 | .03 | .39 | 2.60 | 19.9 | .57 | 5.80 |
| AMIN-4166 | 4166 | 4/16/03 13:00 | RA | 7.07 | 271 | .52 | 29.7 | 1.16 | .15 | .56 | 9.22 | 466 | 11.6 | 6.05 |
| AMIN-4166 | 4166 | 4/16/03 14:00 | FA | 6.62 | 51.1 | .20 | 24.8 | .85 | .02 | .62 | 3.19 | 19.7 | .57 | 5.85 |
| AMIN-4166 | 4166 | 4/16/03 14:00 | RA | 6.29 | 57.8 | .21 | 24.2 | .85 | .02 | .47 | 4.18 | 62.1 | 1.40 | 5.63 |
| AMIN-4166 | 4166 | 4/16/03 15:00 | FA | 6.38 | 47.4 | .15 | 23.9 | .88 | .02 | .55 | 2.68 | 18.3 | .59 | 5.81 |
| AMIN-4166 | 4166 | 4/16/03 15:00 | RA | 6.59 | 68.1 | .20 | 23.4 | .90 | .03 | .44 | 4.06 | 82.1 | 1.94 | 5.32 |
| AMIN-4166 | 4166 | 4/16/03 16:00 | FA | 6.36 | 41.9 | .15 | 23.7 | .90 | .03 | .46 | 2.86 | 14.7 | .52 | 5.58 |
| AMIN-4166 | 4166 | 4/16/03 16:00 | RA | 6.32 | 69.2 | .18 | 23.5 | .96 | .03 | .42 | 4.33 | 84.4 | 2.09 | 5.42 |
| AMIN-4166 | 4166 | 4/17/03 8:37 | FA | 6.51 | 36.0 | .09 | 23.4 | 1.06 | .15 | .32 | 3.59 | 15.6 | .50 | 5.42 |
| AMIN-4166 | 4166 | 4/17/03 8:37 | RA | 6.59 | 64.2 | .12 | 24.8 | 1.07 | .08 | .32 | 5.52 | 68.3 | 1.91 | 5.49 |
| AMIN-4166 | 4166 | 4/17/03 9:48 | FA | 6.38 | 30.7 | .10 | 24.4 | 1.01 | .12 | .32 | 3.56 | 11.9 | .36 | 5.47 |
| AMIN-4166 | 4166 | 4/17/03 9:48 | RA | 6.65 | 57.5 | .13 | 23.8 | 1.04 | .13 | .31 | 5.13 | 67.0 | 1.72 | 5.33 |
| AMIN-4166 | 4166 | 4/17/03 11:01 | FA | 6.67 | 32.6 | .09 | 24.7 | .99 | .11 | .33 | 3.42 | 11.6 | .40 | 5.41 |
| AMIN-4166 | 4166 | 4/17/03 11:01 | RA | 6.61 | 57.6 | .12 | 23.8 | 1.00 | .15 | .31 | 5.17 | 67.4 | 1.81 | 5.42 |
| AMIN-4166 | 4166 | 4/17/03 11:59 | FA | 6.57 | 63.7 | .11 | 25.5 | .98 | .35 | .30 | 5.48 | 95.8 | .67 | 5.62 |
| AMIN-4166 | 4166 | 4/17/03 11:59 | RA | 6.72 | 58.0 | .14 | 24.4 | .98 | .13 | .30 | 4.91 | 61.5 | 1.65 | 5.83 |
| AMIN-4166 | 4166 | 4/17/03 13:55 | FA | 6.04 | 56.6 | .12 | 23.5 | .89 | .10 | .25 | 3.78 | 12.2 | .46 | 5.66 |
| AMIN-4166 | 4166 | 4/17/03 13:55 | RA | 6.46 | 85.2 | .16 | 23.7 | .93 | .02 | .28 | 5.58 | 98.1 | 2.40 | 5.65 |
| AMIN-4916 | 4916 | 4/16/03 13:00 | FA | 6.37 | 24.9 | .34 | 24.3 | 1.23 | .11 | .38 | 2.82 | 8.50 | .25 | 6.22 |
| AMIN-4916 | 4916 | 4/16/03 13:00 | RA | 6.41 | 47.5 | .40 | 24.0 | 1.25 | .03 | .38 | 4.47 | 64.1 | 1.73 | 6.28 |
| AMIN-4916 | 4916 | 4/16/03 14:00 | FA | 6.42 | 30.6 | .40 | 24.2 | 1.09 | .19 | .53 | 2.67 | 15.1 | .49 | 6.14 |
| AMIN-4916 | 4916 | 4/16/03 14:00 | RA | 6.70 | 44.4 | .48 | 24.5 | 1.15 | .03 | .35 | 4.16 | 64.5 | 1.71 | 6.19 |
| AMIN-4916 | 4916 | 4/16/03 16:00 | FA | 6.41 | 28.1 | .39 | 23.4 | 1.18 | .03 | .46 | 3.22 | 13.2 | .46 | 6.09 |
| AMIN-4916 | 4916 | 4/16/03 16:00 | RA | 6.33 | 65.0 | .44 | 22.9 | 1.17 | .02 | .35 | 5.16 | 80.1 | 2.01 | 5.80 |
| AMIN-4916 | 4916 | 4/16/03 17:00 | FA | 6.48 | 28.3 | .30 | 23.4 | 1.17 | .12 | .41 | 3.70 | 10.8 | .54 | 6.10 |
| AMIN-4916 | 4916 | 4/16/03 17:00 | RA | 6.43 | 81.1 | .39 | 23.4 | 1.21 | .03 | .38 | 5.89 | 104 | 2.68 | 6.09 |
| AMIN-4916 | 4916 | 4/16/03 18:00 | FA | 6.30 | 31.6 | .33 | 24.1 | 1.15 | .03 | .51 | 3.59 | 12.8 | .48 | 6.13 |
| AMIN-4916 | 4916 | 4/16/03 18:00 | RA | 6.31 | 74.6 | .42 | 23.5 | 1.18 | .12 | .37 | 5.49 | 87.0 | 2.22 | 5.82 |
| AMIN-4916 | 4916 | 4/16/03 19:00 | FA | 6.51 | 37.5 | .31 | 23.2 | 1.22 | .17 | .53 | 3.42 | 16.3 | .55 | 6.37 |
| AMIN-4916 | 4916 | 4/16/03 19:00 | RA | 6.30 | 82.6 | .41 | 23.4 | 1.25 | .02 | .39 | 5.92 | 107 | 2.92 | 5.55 |
| AMIN-4916 | 4916 | 4/16/03 20:00 | FA | 6.11 | 29.9 | .28 | 23.1 | 1.31 | .03 | .45 | 3.44 | 13.4 | .51 | 5.89 |
| AMIN-4916 | 4916 | 4/16/03 20:00 | RA | 6.27 | 91.0 | .39 | 22.8 | 1.32 | .11 | .41 | 6.41 | 116 | 2.80 | 5.69 |
| AMIN-4916 | 4916 | 4/16/03 21:00 | FA | 6.10 | 28.4 | .29 | 22.9 | 1.39 | .04 | .63 | 3.73 | 17.6 | .53 | 5.65 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Lithum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | mg/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-4916 | 4916 | 4/16/03 21:00 | RA | 6.35 | 95.7 | .44 | 23.1 | 1.47 | .03 | .44 | 6.88 | 119 | 2.85 | 5.73 |
| AMIN-4916 | 4916 | 4/16/03 22:00 | FA | 6.46 | 27.7 | .25 | 23.4 | 1.45 | .02 | .58 | 3.53 | 18.3 | .51 | 5.80 |
| AMIN-4916 | 4916 | 4/16/03 22:00 | RA | 6.29 | 82.6 | .32 | 23.6 | 1.49 | .02 | .46 | 6.59 | 100 | 2.41 | 5.75 |
| AMIN-4916 | 4916 | 4/16/03 23:00 | FA | 6.33 | 27.4 | .27 | 24.0 | 1.51 | .02 | .57 | 3.77 | 24.0 | .57 | 5.91 |
| AMIN-4916 | 4916 | 4/16/03 23:00 | RA | 6.23 | 89.0 | .35 | 22.8 | 1.49 | .03 | .44 | 6.73 | 107 | 2.35 | 5.71 |
| AMIN-4916 | 4916 | 4/17/03 0:00 | FA | 6.35 | 64.3 | .24 | 24.2 | 1.49 | .03 | .55 | 3.83 | 13.0 | .45 | 5.91 |
| AMIN-4916 | 4916 | 4/17/03 0:00 | RA | 6.32 | 91.0 | .29 | 23.8 | 1.48 | .03 | .47 | 7.33 | 114 | 2.74 | 5.77 |
| AMIN-4916 | 4916 | 4/17/03 1:00 | FA | 6.27 | 28.6 | .21 | 23.7 | 1.55 | .02 | .54 | 3.71 | 13.2 | .40 | 5.97 |
| AMIN-4916 | 4916 | 4/17/03 1:00 | RA | 6.37 | 96.5 | .30 | 23.6 | 1.56 | .02 | .46 | 7.70 | 120 | 2.92 | 5.58 |
| AMIN-4916 | 4916 | 4/17/03 8:50 | FA | 6.40 | 50.2 | .09 | 25.1 | 1.63 | .10 | .42 | 10.4 | 6.64 | .71 | 5.82 |
| AMIN-4916 | 4916 | 4/17/03 8:50 | RA | 6.67 | 96.9 | .13 | 24.3 | 1.65 | .16 | .42 | 8.70 | 72.4 | 2.06 | 5.68 |
| AMIN-4916 | 4916 | 4/17/03 9:57 | FA | 6.56 | 49.5 | .09 | 24.4 | 1.61 | .21 | .40 | 6.19 | 5.98 | .29 | 5.92 |
| AMIN-4916 | 4916 | 4/17/03 9:57 | RA | 6.72 | 97.3 | .12 | 24.1 | 1.64 | .21 | .41 | 8.29 | 70.1 | 2.05 | 5.89 |
| AMIN-4916 | 4916 | 4/17/03 11:08 | FA | 6.50 | 51.5 | .08 | 24.5 | 1.57 | .13 | .40 | 5.46 | 10.1 | .32 | 5.78 |
| AMIN-4916 | 4916 | 4/17/03 11:08 | RA | 6.92 | 99.6 | .12 | 24.5 | 1.54 | .13 | .38 | 8.18 | 71.1 | 2.08 | 5.71 |
| AMIN-4916 | 4916 | 4/17/03 12:06 | FA | 6.18 | 58.3 | .12 | 25.0 | 1.48 | .13 | .44 | 5.36 | 7.12 | .34 | 5.91 |
| AMIN-4916 | 4916 | 4/17/03 12:06 | RA | 6.76 | 102 | .11 | 23.6 | 1.50 | .12 | .40 | 8.40 | 73.9 | 2.37 | 5.89 |
| AMIN-4916 | 4916 | 4/17/03 14:02 | FA | 6.25 | 50.9 | .10 | 24.2 | 1.38 | .02 | .40 | 4.55 | 7.79 | .35 | 6.00 |
| AMIN-4916 | 4916 | 4/17/03 14:02 | RA | 6.77 | 186 | .26 | 25.3 | 1.42 | .05 | .44 | 9.62 | 233 | 4.91 | 6.12 |
| AMIN-5536 | 5536 | 4/16/03 13:00 | FA | 6.21 | 54.6 | .10 | 24.0 | 1.70 | .01 | 1.16 | 3.91 | 7.46 | .48 | 6.10 |
| AMIN-5536 | 5536 | 4/16/03 13:00 | RA | 6.56 | 73.8 | .14 | 24.2 | 1.79 | .03 | .63 | 6.78 | 76.5 | 2.28 | 6.58 |
| AMIN-5536 | 5536 | 4/16/03 14:00 | FA | 6.43 | 34.5 | .10 | 24.3 | 1.54 | .12 | .83 | 4.02 | 12.4 | .49 | 6.24 |
| AMIN-5536 | 5536 | 4/16/03 14:00 | RA | 6.41 | 80.6 | .13 | 23.8 | 1.56 | .13 | .54 | 6.72 | 80.1 | 2.38 | 5.96 |
| AMIN-5536 | 5536 | 4/16/03 15:00 | FA | 6.33 | 23.0 | .11 | 23.7 | 1.49 | .02 | 1.01 | 3.50 | 13.2 | .49 | 5.81 |
| AMIN-5536 | 5536 | 4/16/03 15:00 | RA | 6.30 | 67.6 | .11 | 23.3 | 1.52 | .14 | .51 | 5.65 | 71.0 | 2.26 | 6.12 |
| AMIN-5536 | 5536 | 4/16/03 16:00 | FA | 6.28 | 27.1 | .10 | 23.5 | 1.51 | .02 | .92 | 3.77 | 14.0 | .53 | 5.94 |
| AMIN-5536 | 5536 | 4/16/03 16:00 | RA | 6.54 | 76.5 | .14 | 23.2 | 1.51 | .03 | .54 | 6.38 | 76.0 | 2.38 | 5.97 |
| AMIN-5536 | 5536 | 4/16/03 17:00 | FA | 6.27 | 28.9 | .10 | 23.0 | 1.50 | .02 | .84 | 4.76 | 11.7 | .50 | 6.00 |
| AMIN-5536 | 5536 | 4/16/03 17:00 | RA | 6.40 | 83.6 | .14 | 23.1 | 1.55 | .03 | .53 | 6.50 | 77.6 | 2.46 | 5.88 |
| AMIN-5536 | 5536 | 4/16/03 18:00 | FA | 6.20 | 27.9 | .11 | 23.2 | 1.50 | .05 | 1.03 | 3.99 | 13.9 | .59 | 5.62 |
| AMIN-5536 | 5536 | 4/16/03 18:00 | RA | 6.66 | 90.9 | .13 | 23.1 | 1.51 | .02 | .54 | 6.36 | 88.7 | 2.51 | 5.77 |
| AMIN-5536 | 5536 | 4/16/03 19:00 | FA | 6.05 | 38.1 | .10 | 22.5 | 1.51 | .01 | .80 | 3.97 | 13.6 | .57 | 5.67 |
| AMIN-5536 | 5536 | 4/16/03 19:00 | RA | 6.14 | 93.3 | .15 | 22.4 | 1.50 | .13 | .53 | 6.71 | 95.0 | 2.73 | 5.59 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Lithum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | mg/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-5536 | 5536 | 4/16/03 20:00 | FA | 6.10 | 22.4 | .10 | 22.8 | 1.62 | .02 | .76 | 4.07 | 14.5 | .58 | 5.81 |
| AMIN-5536 | 5536 | 4/16/03 20:00 | RA | 6.28 | 88.5 | .14 | 22.8 | 1.60 | .13 | .57 | 6.94 | 93.6 | 2.69 | 5.69 |
| AMIN-5536 | 5536 | 4/16/03 21:00 | FA | 6.35 | 27.5 | .10 | 23.3 | 1.76 | .15 | .93 | 4.48 | 14.5 | .57 | 6.04 |
| AMIN-5536 | 5536 | 4/16/03 21:00 | RA | 6.44 | 90.0 | .14 | 22.6 | 1.66 | .04 | .60 | 7.57 | 96.3 | 2.66 | 5.89 |
| AMIN-5536 | 5536 | 4/16/03 22:00 | FA | 6.20 | 23.8 | .09 | 22.9 | 1.70 | .02 | 1.04 | 3.95 | 16.0 | .51 | 5.81 |
| AMIN-5536 | 5536 | 4/16/03 22:00 | RA | 6.46 | 90.2 | .14 | 22.9 | 1.68 | .03 | .61 | 7.18 | 107 | 2.75 | 5.71 |
| AMIN-5536 | 5536 | 4/16/03 23:00 | FA | 6.49 | 29.8 | .09 | 20.4 | 1.51 | .01 | .70 | 3.40 | 14.6 | .42 | 5.10 |
| AMIN-5536 | 5536 | 4/16/03 23:00 | RA | 6.52 | 91.5 | .14 | 22.6 | 1.65 | .03 | .61 | 7.18 | 109 | 2.74 | 5.77 |
| AMIN-5536 | 5536 | 4/17/03 0:00 | FA | 6.33 | 32.3 | .10 | 22.7 | 1.66 | .02 | 1.00 | 3.78 | 15.5 | .47 | 5.49 |
| AMIN-5536 | 5536 | 4/17/03 0:00 | RA | 6.59 | 89.0 | .13 | 23.7 | 1.73 | .03 | .64 | 7.28 | 105 | 2.63 | 5.83 |
| AMIN-5536 | 5536 | 4/17/03 1:00 | FA | 6.27 | 24.8 | .10 | 23.2 | 1.76 | .08 | .91 | 3.90 | 11.3 | .38 | 5.89 |
| AMIN-5536 | 5536 | 4/17/03 1:00 | RA | 6.45 | 87.8 | .12 | 23.2 | 1.77 | .03 | .63 | 7.09 | 101 | 2.67 | 5.77 |
| AMIN-5536 | 5536 | 4/17/03 9:06 | FA | 6.59 | 53.3 | .07 | 23.5 | 1.73 | .12 | .58 | 6.20 | 8.22 | .38 | 5.91 |
| AMIN-5536 | 5536 | 4/17/03 9:06 | RA | 6.70 | 118 | .12 | 23.5 | 1.73 | .02 | .60 | 10.1 | 93.4 | 2.79 | 5.82 |
| AMIN-5536 | 5536 | 4/17/03 10:07 | FA | 6.20 | 53.5 | .09 | 23.1 | 1.68 | .18 | .60 | 6.29 | 15.9 | .58 | 5.78 |
| AMIN-5536 | 5536 | 4/17/03 10:07 | RA | 6.72 | 117 | .13 | 22.8 | 1.66 | .11 | .54 | 10.2 | 90.7 | 2.74 | 5.91 |
| AMIN-5536 | 5536 | 4/17/03 11:13 | FA | 6.57 | 58.5 | .09 | 24.0 | 1.71 | .11 | .61 | 6.20 | 10.1 | .45 | 5.93 |
| AMIN-5536 | 5536 | 4/17/03 11:13 | RA | 6.58 | 123 | .11 | 24.0 | 1.69 | .22 | .59 | 10.5 | 98.1 | 3.06 | 5.81 |
| AMIN-5536 | 5536 | 4/17/03 12:14 | FA | 6.25 | 75.6 | .10 | 23.6 | 1.58 | .08 | .61 | 6.16 | 15.2 | .50 | 5.97 |
| AMIN-5536 | 5536 | 4/17/03 12:14 | RA | 6.81 | 128 | .13 | 24.3 | 1.65 | .12 | .59 | 10.1 | 105 | 3.27 | 5.90 |
| AMIN-5536 | 5536 | 4/17/03 14:10 | FA | 6.38 | 60.0 | .10 | 24.1 | 1.45 | .02 | .53 | 5.04 | 25.8 | 1.01 | 6.30 |
| AMIN-5536 | 5536 | 4/17/03 14:10 | RA | 7.05 | 253 | .27 | 24.9 | 1.53 | .07 | .67 | 11.2 | 293 | 6.34 | 6.17 |
| AMIN-6745 | 6745 | 4/16/03 13:00 | FA | 6.35 | 27.6 | .26 | 22.8 | 1.88 | .11 | .98 | 2.80 | 7.31 | .15 | 5.99 |
| AMIN-6745 | 6745 | 4/16/03 13:00 | RA | 6.95 | 134 | .44 | 24.0 | 2.06 | .21 | .88 | 8.50 | 193 | 3.84 | 6.66 |
| AMIN-6745 | 6745 | 4/16/03 14:00 | FA | 6.39 | 26.3 | .29 | 23.3 | 1.81 | .12 | .88 | 3.01 | 7.01 | .30 | 6.29 |
| AMIN-6745 | 6745 | 4/16/03 14:00 | RA | 6.47 | 111 | .42 | 23.8 | 1.91 | .04 | .80 | 7.87 | 172 | 3.57 | 6.37 |
| AMIN-6745 | 6745 | 4/16/03 15:00 | FA | 6.37 | 21.5 | .28 | 23.5 | 1.60 | .12 | .85 | 2.88 | 12.2 | .32 | 6.45 |
| AMIN-6745 | 6745 | 4/16/03 15:00 | RA | 6.72 | 114 | .47 | 23.2 | 1.71 | .11 | .76 | 7.85 | 194 | 4.29 | 6.46 |
| AMIN-6745 | 6745 | 4/16/03 16:00 | FA | 6.22 | 22.6 | .31 | 22.5 | 1.63 | .15 | .92 | 3.11 | 15.8 | .40 | 6.24 |
| AMIN-6745 | 6745 | 4/16/03 16:00 | RA | 6.48 | 130 | .47 | 22.8 | 1.69 | .14 | .76 | 8.52 | 202 | 4.89 | 6.43 |
| AMIN-6745 | 6745 | 4/16/03 17:00 | FA | 6.55 | 20.7 | .26 | 21.5 | 1.62 | .16 | 1.04 | 3.00 | 16.2 | .28 | 6.35 |
| AMIN-6745 | 6745 | 4/16/03 17:00 | RA | 6.62 | 141 | .43 | 23.5 | 1.77 | .03 | .78 | 9.14 | 225 | 5.61 | 6.25 |
| AMIN-6745 | 6745 | 4/16/03 18:00 | FA | 6.66 | 24.1 | .24 | 22.7 | 1.65 | .02 | .91 | 3.14 | 13.5 | .39 | 6.30 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Lithum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | mg/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-6745 | 6745 | 4/16/03 18:00 | RA | 6.91 | 178 | .44 | 23.8 | 1.76 | .04 | .80 | 10.7 | 277 | 6.56 | 6.36 |
| AMIN-6745 | 6745 | 4/16/03 19:00 | FA | 6.30 | 30.3 | .29 | 22.9 | 1.69 | .03 | .99 | 3.75 | 24.7 | .96 | 6.22 |
| AMIN-6745 | 6745 | 4/16/03 19:00 | RA | 6.65 | 160 | .43 | 23.0 | 1.78 | .04 | .79 | 9.49 | 228 | 5.36 | 6.20 |
| AMIN-6745 | 6745 | 4/16/03 20:00 | FA | 6.43 | 26.7 | .29 | 23.0 | 1.77 | .01 | .94 | 3.59 | 13.3 | .62 | 6.44 |
| AMIN-6745 | 6745 | 4/16/03 20:00 | RA | 6.54 | 165 | .45 | 22.7 | 1.84 | .06 | .80 | 9.77 | 238 | 5.68 | 6.24 |
| AMIN-6745 | 6745 | 4/16/03 21:00 | FA | 6.62 | 24.8 | .27 | 22.9 | 1.88 | .02 | .97 | 3.55 | 13.8 | .37 | 6.31 |
| AMIN-6745 | 6745 | 4/16/03 21:00 | RA | 6.66 | 165 | .43 | 23.2 | 1.96 | .04 | .85 | 10.4 | 236 | 5.38 | 6.17 |
| AMIN-6745 | 6745 | 4/16/03 22:00 | FA | 6.43 | 22.3 | .24 | 22.6 | 1.96 | .03 | .88 | 3.43 | 8.83 | .25 | 6.16 |
| AMIN-6745 | 6745 | 4/16/03 22:00 | RA | 6.53 | 148 | .37 | 22.3 | 1.93 | .04 | .82 | 9.60 | 212 | 4.48 | 6.05 |
| AMIN-6745 | 6745 | 4/16/03 23:00 | FA | 6.28 | 24.1 | .20 | 21.8 | 1.84 | .01 | 1.06 | 3.22 | 12.0 | .28 | 5.97 |
| AMIN-6745 | 6745 | 4/16/03 23:00 | RA | 6.43 | 142 | .40 | 23.4 | 2.00 | .03 | .87 | 9.90 | 213 | 4.71 | 6.18 |
| AMIN-6745 | 6745 | 4/17/03 0:00 | FA | 6.30 | 23.0 | .23 | 22.6 | 1.93 | .01 | 1.11 | 3.29 | 10.5 | .25 | 5.99 |
| AMIN-6745 | 6745 | 4/17/03 0:00 | RA | 6.71 | 165 | .41 | 23.7 | 2.07 | .03 | .89 | 10.6 | 247 | 5.38 | 6.18 |
| AMIN-6745 | 6745 | 4/17/03 1:00 | FA | 6.23 | 22.8 | .21 | 22.9 | 1.97 | .01 | .93 | 3.32 | 7.03 | .19 | 5.83 |
| AMIN-6745 | 6745 | 4/17/03 1:00 | RA | 6.79 | 154 | .33 | 24.2 | 2.14 | .03 | .88 | 10.3 | 229 | 4.75 | 6.18 |
| AMIN-6745 | 6745 | 4/17/03 2:00 | FA | 6.24 | 22.0 | .18 | 22.2 | 1.91 | .07 | .87 | 3.21 | 5.85 | .14 | 6.05 |
| AMIN-6745 | 6745 | 4/17/03 2:00 | RA | 6.29 | 147 | .31 | 23.5 | 2.06 | .18 | .87 | 10.1 | 217 | 4.54 | 6.02 |
| AMIN-6745 | 6745 | 4/17/03 3:00 | FA | 6.34 | 20.9 | .20 | 22.2 | 1.91 | .08 | 1.08 | 3.10 | 8.36 | .18 | 5.66 |
| AMIN-6745 | 6745 | 4/17/03 3:00 | RA | 6.50 | 156 | .33 | 22.5 | 2.03 | .18 | .86 | 9.84 | 224 | 4.44 | 5.94 |
| AMIN-6745 | 6745 | 4/17/03 4:00 | FA | 6.53 | 23.5 | .18 | 23.2 | 2.00 | .13 | 1.09 | 3.28 | 8.65 | .22 | 6.11 |
| AMIN-6745 | 6745 | 4/17/03 4:00 | RA | 6.60 | 139 | .30 | 23.7 | 2.06 | .13 | .86 | 9.52 | 199 | 3.99 | 6.07 |
| AMIN-6745 | 6745 | 4/17/03 5:00 | FA | 6.45 | 19.5 | .11 | 22.1 | 1.82 | .16 | 1.02 | 2.99 | 6.72 | .19 | 5.92 |
| AMIN-6745 | 6745 | 4/17/03 5:00 | RA | 6.65 | 141 | .26 | 23.2 | 1.94 | .19 | .87 | 9.38 | 205 | 4.17 | 6.04 |
| AMIN-6745 | 6745 | 4/17/03 6:00 | FA | 6.33 | 16.4 | .14 | 21.6 | 1.84 | .22 | .94 | 3.21 | 91.2 | .14 | 6.03 |
| AMIN-6745 | 6745 | 4/17/03 6:00 | RA | 6.65 | 145 | .30 | 22.6 | 1.89 | .16 | .84 | 9.11 | 215 | 4.00 | 5.91 |
| AMIN-6745 | 6745 | 4/17/03 7:00 | FA | 6.52 | 20.9 | .16 | 22.6 | 1.98 | .12 | 1.37 | 3.08 | 8.36 | .14 | 6.54 |
| AMIN-6745 | 6745 | 4/17/03 7:00 | RA | 6.58 | 154 | .33 | 23.0 | 2.04 | .25 | .94 | 9.84 | 221 | 4.56 | 7.06 |
| AMIN-6745 | 6745 | 4/17/03 9:17 | FA | 6.65 | 47.3 | .08 | 23.4 | 2.06 | .02 | .84 | 4.66 | 7.18 | .13 | 5.86 |
| AMIN-6745 | 6745 | 4/17/03 9:17 | RA | 6.44 | 153 | .12 | 24.1 | 2.15 | .03 | .84 | 11.6 | 186 | 3.78 | 6.07 |
| AMIN-6745 | 6745 | 4/17/03 10:16 | FA | 6.63 | 52.1 | .07 | 23.5 | 2.12 | .12 | .89 | 6.03 | 13.0 | .12 | 6.01 |
| AMIN-6745 | 6745 | 4/17/03 10:16 | RA | 6.66 | 172 | .14 | 23.9 | 2.16 | .13 | .88 | 11.7 | 184 | 3.59 | 6.24 |
| AMIN-6745 | 6745 | 4/17/03 11:23 | FA | 6.77 | 51.7 | .07 | 24.3 | 2.07 | .16 | .86 | 5.46 | 13.0 | .18 | 6.17 |
| AMIN-6745 | 6745 | 4/17/03 11:23 | RA | 6.62 | 163 | .12 | 25.7 | 2.18 | .13 | .86 | 12.4 | 191 | 3.89 | 6.49 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Lithum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | mg/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-6745 | 6745 | 4/17/03 12:20 | FA | 6.50 | 53.7 | .10 | 23.5 | 1.98 | .12 | .86 | 4.72 | 12.9 | .15 | 6.57 |
| AMIN-6745 | 6745 | 4/17/03 12:20 | RA | 6.95 | 165 | .11 | 24.1 | 2.04 | .10 | .79 | 11.7 | 174 | 3.87 | 6.29 |
| AMIN-6745 | 6745 | 4/17/03 14:16 | FA | 6.39 | 61.3 | .09 | 23.7 | 1.82 | .06 | .83 | 5.21 | 21.2 | .50 | 6.32 |
| AMIN-6745 | 6745 | 4/17/03 14:16 | RA | 6.66 | 166 | .15 | 23.5 | 1.89 | .02 | .78 | 11.3 | 186 | 4.46 | 6.52 |
| AMIN-7306 | 7306 | 4/16/03 13:00 | FA | 6.61 | 37.8 | .10 | 24.5 | 2.25 | .02 | 1.00 | 3.62 | 22.2 | .53 | 6.36 |
| AMIN-7306 | 7306 | 4/16/03 13:00 | RA | 6.63 | 122 | .14 | 24.1 | 2.34 | .04 | .82 | 8.57 | 175 | 3.85 | 6.10 |
| AMIN-7306 | 7306 | 4/16/03 14:00 | FA | 6.62 | 36.7 | .09 | 23.7 | 2.07 | .01 | .88 | 3.56 | 18.6 | .42 | 6.43 |
| AMIN-7306 | 7306 | 4/16/03 14:00 | RA | 6.69 | 124 | .15 | 23.9 | 2.13 | .02 | .76 | 8.49 | 176 | 3.88 | 6.35 |
| AMIN-7306 | 7306 | 4/16/03 15:00 | FA | 6.40 | 40.5 | .08 | 24.0 | 1.94 | .02 | .80 | 3.80 | 18.1 | .44 | 6.78 |
| AMIN-7306 | 7306 | 4/16/03 15:00 | RA | 6.53 | 126 | .16 | 24.6 | 2.05 | .03 | .76 | 8.52 | 164 | 3.80 | 6.35 |
| AMIN-7306 | 7306 | 4/16/03 16:00 | FA | 6.23 | 25.2 | .10 | 23.2 | 1.86 | .02 | .82 | 3.52 | 17.0 | .50 | 6.39 |
| AMIN-7306 | 7306 | 4/16/03 16:00 | RA | 6.77 | 127 | .19 | 24.2 | 1.88 | .03 | .77 | 7.91 | 171 | 4.63 | 6.21 |
| AMIN-7306 | 7306 | 4/16/03 17:00 | FA | 6.54 | 41.6 | .10 | 22.5 | 1.95 | .10 | .97 | 4.48 | 37.2 | .88 | 6.43 |
| AMIN-7306 | 7306 | 4/16/03 17:00 | RA | 6.42 | 151 | .22 | 23.7 | 2.06 | .15 | .77 | 9.71 | 198 | 5.17 | 6.22 |
| AMIN-7306 | 7306 | 4/16/03 18:00 | FA | 6.46 | 32.3 | .13 | 22.2 | 1.94 | .02 | .81 | 3.85 | 13.7 | .41 | 6.76 |
| AMIN-7306 | 7306 | 4/16/03 18:00 | RA | 6.39 | 167 | .20 | 22.9 | 2.02 | .16 | .79 | 10.3 | 230 | 6.03 | 6.14 |
| AMIN-7306 | 7306 | 4/16/03 19:00 | FA | 6.37 | 37.3 | .10 | 23.2 | 1.90 | .02 | .77 | 4.02 | 17.1 | .52 | 6.32 |
| AMIN-7306 | 7306 | 4/16/03 19:00 | RA | 6.52 | 143 | .15 | 23.5 | 2.00 | .04 | .74 | 9.17 | 161 | 4.06 | 6.30 |
| AMIN-7306 | 7306 | 4/16/03 20:00 | FA | 6.30 | 36.9 | .09 | 22.7 | 2.01 | .02 | .80 | 4.18 | 15.9 | .51 | 6.12 |
| AMIN-7306 | 7306 | 4/16/03 20:00 | RA | 6.71 | 146 | .15 | 23.2 | 2.06 | .10 | .77 | 9.61 | 177 | 4.28 | 6.21 |
| AMIN-7306 | 7306 | 4/16/03 21:00 | FA | 6.42 | 38.1 | .10 | 22.2 | 1.97 | .15 | .83 | 3.84 | 16.7 | .46 | 6.14 |
| AMIN-7306 | 7306 | 4/16/03 21:00 | RA | 6.64 | 158 | .16 | 23.0 | 2.10 | .11 | .81 | 9.82 | 191 | 4.77 | 5.98 |
| AMIN-7306 | 7306 | 4/16/03 22:00 | FA | 6.57 | 33.6 | .10 | 23.1 | 2.10 | .02 | .83 | 4.09 | 17.7 | .57 | 6.26 |
| AMIN-7306 | 7306 | 4/16/03 22:00 | RA | 6.41 | 147 | .16 | 23.4 | 2.23 | .04 | .83 | 10.3 | 189 | 4.58 | 6.13 |
| AMIN-7306 | 7306 | 4/16/03 23:00 | FA | 6.61 | 33.2 | .08 | 22.6 | 2.07 | .01 | 1.33 | 3.90 | 16.9 | .44 | 6.07 |
| AMIN-7306 | 7306 | 4/16/03 23:00 | RA | 6.41 | 152 | .18 | 23.3 | 2.22 | .15 | .84 | 10.2 | 191 | 4.52 | 5.88 |
| AMIN-7306 | 7306 | 4/17/03 0:00 | FA | 6.41 | 34.4 | .08 | 22.9 | 2.05 | .02 | .88 | 3.83 | 12.8 | .34 | 6.03 |
| AMIN-7306 | 7306 | 4/17/03 0:00 | RA | 6.51 | 147 | .14 | 23.2 | 2.15 | .04 | .84 | 10.1 | 191 | 4.51 | 6.00 |
| AMIN-7306 | 7306 | 4/17/03 9:23 | FA | 6.50 | 46.7 | .09 | 23.4 | 2.16 | .03 | .82 | 4.80 | 6.46 | .18 | 5.96 |
| AMIN-7306 | 7306 | 4/17/03 9:23 | RA | 6.72 | 168 | .13 | 23.2 | 2.19 | .02 | .80 | 11.5 | 189 | 3.67 | 5.98 |
| AMIN-7306 | 7306 | 4/17/03 10:27 | RA | 6.75 | 158 | .09 | 22.9 | 2.12 | .11 | .81 | 11.3 | 179 | 3.72 | 5.94 |
| AMIN-7306 | 7306 | 4/17/03 11:29 | FA | 6.77 | 55.0 | .09 | 24.1 | 2.16 | .13 | .82 | 5.18 | 12.6 | .20 | 6.19 |
| AMIN-7306 | 7306 | 4/17/03 11:29 | RA | 6.75 | 157 | .18 | 23.5 | 2.17 | .15 | .85 | 11.7 | 172 | 3.66 | 6.42 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Lithium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | mg/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-7306 | 7306 | 4/17/03 12:26 | FA | 6.77 | 58.5 | .07 | 24.0 | 2.18 | .10 | .84 | 4.98 | 4.89 | .15 | 6.41 |
| AMIN-7306 | 7306 | 4/17/03 12:26 | RA | 6.90 | 163 | .09 | 24.1 | 2.24 | .12 | .83 | 11.6 | 175 | 3.87 | 6.40 |
| AMIN-7306 | 7306 | 4/17/03 14:22 | FA | 6.39 | 78.7 | .12 | 24.0 | 1.95 | .02 | .76 | 5.08 | 7.80 | .25 | 6.17 |
| AMIN-7306 | 7306 | 4/17/03 14:22 | RA | 6.74 | 162 | .13 | 24.0 | 1.99 | .11 | .75 | 11.0 | 178 | 4.16 | 6.05 |
| AMIN-7858 | 7858 | 4/16/03 13:00 | FA | 6.37 | 24.3 | .19 | 23.2 | 2.32 | .11 | 1.11 | 3.00 | 4.34 | .13 | 6.97 |
| AMIN-7858 | 7858 | 4/16/03 13:00 | RA | 6.93 | 139 | .26 | 23.8 | 2.43 | .13 | .99 | 8.79 | 198 | 3.99 | 6.95 |
| AMIN-7858 | 7858 | 4/16/03 14:00 | FA | 6.85 | 27.7 | .23 | 23.4 | 2.19 | .11 | 1.08 | 3.19 | 10.7 | .24 | 7.12 |
| AMIN-7858 | 7858 | 4/16/03 14:00 | RA | 7.41 | 267 | .54 | 25.3 | 2.42 | .20 | 1.05 | 12.8 | 451 | 9.45 | 6.95 |
| AMIN-7858 | 7858 | 4/16/03 17:00 | FA | 6.60 | 23.5 | .17 | 21.7 | 2.00 | .08 | 1.23 | 3.06 | 7.96 | .21 | 7.17 |
| AMIN-7858 | 7858 | 4/16/03 17:00 | RA | 6.70 | 155 | .25 | 23.0 | 2.18 | .09 | 1.05 | 8.69 | 232 | 4.67 | 7.00 |
| AMIN-7858 | 7858 | 4/16/03 18:00 | FA | 6.23 | 48.3 | .16 | 21.1 | 2.01 | .08 | 1.30 | 3.16 | 4.47 | .11 | 6.66 |
| AMIN-7858 | 7858 | 4/16/03 18:00 | RA | 6.53 | 155 | .26 | 22.3 | 2.17 | .14 | 1.01 | 8.70 | 228 | 4.72 | 6.68 |
| AMIN-7858 | 7858 | 4/16/03 19:00 | FA | 6.20 | 22.9 | .19 | 21.8 | 2.00 | .07 | 1.07 | 3.31 | 4.43 | .13 | 6.62 |
| AMIN-7858 | 7858 | 4/16/03 19:00 | RA | 6.83 | 170 | .25 | 22.1 | 2.14 | .09 | .97 | 8.90 | 250 | 4.63 | 6.52 |
| AMIN-7858 | 7858 | 4/16/03 20:00 | FA | 6.39 | 24.6 | .19 | 21.5 | 2.81 | .13 | 1.53 | 3.25 | 6.64 | .17 | 7.19 |
| AMIN-7858 | 7858 | 4/16/03 20:00 | RA | 6.73 | 153 | .26 | 22.7 | 2.19 | .13 | .98 | 9.12 | 241 | 4.45 | 6.78 |
| AMIN-7858 | 7858 | 4/16/03 21:00 | FA | 6.35 | 24.2 | .15 | 22.0 | 2.18 | .15 | 1.48 | 3.11 | 7.40 | .18 | 7.04 |
| AMIN-7858 | 7858 | 4/16/03 21:00 | RA | 6.50 | 154 | .24 | 21.9 | 2.24 | .13 | .94 | 8.76 | 213 | 4.28 | 6.34 |
| AMIN-7858 | 7858 | 4/16/03 22:00 | FA | 6.38 | 24.3 | .16 | 21.5 | 2.13 | .08 | 1.29 | 3.32 | 5.78 | .15 | 6.66 |
| AMIN-7858 | 7858 | 4/16/03 22:00 | RA | 6.51 | 144 | .26 | 22.6 | 2.28 | .10 | .92 | 9.24 | 204 | 4.23 | 6.51 |
| AMIN-7858 | 7858 | 4/16/03 23:00 | FA | 6.32 | 25.1 | .15 | 21.5 | 2.38 | .08 | .96 | 3.51 | 19.7 | .15 | 7.10 |
| AMIN-7858 | 7858 | 4/16/03 23:00 | RA | 6.68 | 151 | .26 | 23.3 | 2.44 | .12 | .98 | 9.56 | 208 | 4.25 | 6.73 |
| AMIN-7858 | 7858 | 4/17/03 0:00 | FA | 6.15 | 22.7 | .18 | 21.4 | 2.19 | .09 | 1.35 | 3.27 | 5.61 | .13 | 6.07 |
| AMIN-7858 | 7858 | 4/17/03 0:00 | RA | 6.72 | 144 | .23 | 22.3 | 2.33 | .13 | .94 | 9.18 | 205 | 3.95 | 6.33 |
| AMIN-7858 | 7858 | 4/17/03 1:00 | FA | 6.45 | 24.0 | .12 | 21.1 | 2.15 | .06 | 1.26 | 3.24 | 4.11 | .11 | 6.64 |
| AMIN-7858 | 7858 | 4/17/03 1:00 | RA | 6.55 | 140 | .23 | 22.8 | 2.35 | .12 | .93 | 9.35 | 195 | 3.93 | 6.43 |
| AMIN-7858 | 7858 | 4/17/03 2:00 | FA | 6.41 | 24.8 | .12 | 21.5 | 2.19 | .09 | 1.29 | 3.30 | 4.42 | .12 | 6.22 |
| AMIN-7858 | 7858 | 4/17/03 2:00 | RA | 6.84 | 146 | .22 | 22.4 | 2.29 | .13 | .90 | 8.96 | 194 | 3.77 | 6.17 |
| AMIN-7858 | 7858 | 4/17/03 3:00 | FA | 6.56 | 23.7 | .14 | 22.5 | 2.30 | .09 | 1.06 | 3.39 | 3.15 | .10 | 6.29 |
| AMIN-7858 | 7858 | 4/17/03 3:00 | RA | 6.82 | 141 | .19 | 23.0 | 2.34 | .12 | .91 | 9.01 | 191 | 3.73 | 6.29 |
| AMIN-7858 | 7858 | 4/17/03 4:00 | FA | 6.41 | 25.6 | .15 | 22.8 | 2.24 | .12 | 1.18 | 3.31 | 4.66 | .11 | 6.77 |
| AMIN-7858 | 7858 | 4/17/03 4:00 | RA | 6.30 | 131 | .18 | 23.2 | 2.35 | .13 | .90 | 8.87 | 174 | 3.54 | 6.25 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Silica | Aluminum | Arsenic | Barium | Cadmium | Chromium | Cobalt | Copper | Iron | Lead | Lithum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | mg/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-7858 | 7858 | 4/17/03 5:00 | FA | 6.55 | 26.4 | .12 | 22.7 | 2.28 | .10 | 1.31 | 3.19 | 4.96 | .12 | 6.26 |
| AMIN-7858 | 7858 | 4/17/03 5:00 | RA | 6.55 | 135 | .20 | 23.3 | 2.38 | .17 | .91 | 8.75 | 169 | 3.47 | 6.27 |
| AMIN-7858 | 7858 | 4/17/03 6:00 | FA | 6.45 | 26.3 | .13 | 22.6 | 2.27 | .10 | 1.50 | 3.21 | 5.50 | .13 | 6.03 |
| AMIN-7858 | 7858 | 4/17/03 6:00 | RA | 6.76 | 131 | .17 | 22.5 | 2.36 | .10 | .89 | 8.78 | 175 | 3.32 | 6.32 |
| AMIN-7858 | 7858 | 4/17/03 9:23 | FA | 6.88 | 53.1 | .07 | 23.9 | 2.45 | .02 | .94 | 4.88 | 4.54 | .17 | 6.48 |
| AMIN-7858 | 7858 | 4/17/03 9:23 | RA | 7.22 | 175 | .15 | 23.7 | 2.44 | .05 | .95 | 11.3 | 194 | 3.77 | 6.37 |
| AMIN-7858 | 7858 | 4/17/03 10:38 | FA | 6.51 | 54.3 | .09 | 23.5 | 2.36 | .14 | .95 | 4.70 | 4.26 | .12 | 6.49 |
| AMIN-7858 | 7858 | 4/17/03 10:38 | RA | 7.05 | 180 | .13 | 24.3 | 2.51 | .12 | .96 | 11.6 | 198 | 3.95 | 6.65 |
| AMIN-7858 | 7858 | 4/17/03 11:35 | FA | 6.86 | 61.9 | .07 | 23.8 | 2.30 | .10 | .96 | 4.87 | 6.61 | .19 | 6.47 |
| AMIN-7858 | 7858 | 4/17/03 11:35 | RA | 6.94 | 180 | .16 | 24.2 | 2.47 | .12 | .96 | 11.6 | 202 | 4.11 | 6.56 |
| AMIN-7858 | 7858 | 4/17/03 12:45 | FA | 6.68 | 60.8 | .09 | 24.1 | 2.26 | .11 | 1.00 | 4.65 | 3.81 | .16 | 7.22 |
| AMIN-7858 | 7858 | 4/17/03 12:45 | RA | 6.94 | 202 | .10 | 24.2 | 2.42 | .15 | .99 | 11.5 | 204 | 4.21 | 6.79 |
| AMIN-7858 | 7858 | 4/17/03 14:32 | FA | 6.64 | 66.9 | .09 | 23.8 | 2.10 | .11 | 1.01 | 4.83 | 7.15 | .25 | 7.00 |
| AMIN-7858 | 7858 | 4/17/03 14:32 | RA | 7.09 | 188 | .12 | 24.7 | 2.22 | .09 | 1.00 | 11.5 | 249 | 4.53 | 6.62 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Manganese | Molybdenum | Nickel | Silver | Strontium | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-4166 | 4166 | 4/16/03 13:00 | FA | 988 | 1.33 | .51 | .004 | 444 | .05 | 490 |
| AMIN-4166 | 4166 | 4/16/03 13:00 | RA | 310 | 1.83 | .66 | .10 | 461 | .36 | 355 |
| AMIN-4166 | 4166 | 4/16/03 14:00 | FA | 160 | 1.27 | 11.3 | .004 | 452 | .05 | 305 |
| AMIN-4166 | 4166 | 4/16/03 14:00 | RA | 155 | 1.28 | 11.1 | .01 | 442 | .07 | 298 |
| AMIN-4166 | 4166 | 4/16/03 15:00 | FA | 172 | 1.19 | .70 | .004 | 416 | .06 | 276 |
| AMIN-4166 | 4166 | 4/16/03 15:00 | RA | 179 | 1.16 | .64 | .02 | 417 | .09 | 285 |
| AMIN-4166 | 4166 | 4/16/03 16:00 | FA | 183 | 1.18 | .69 | .003 | 420 | .06 | 290 |
| AMIN-4166 | 4166 | 4/16/03 16:00 | RA | 189 | 1.17 | .62 | .02 | 412 | .09 | 297 |
| AMIN-4166 | 4166 | 4/17/03 8:37 | FA | 188 | 1.21 | .40 | .03 | 418 | .03 | 395 |
| AMIN-4166 | 4166 | 4/17/03 8:37 | RA | 191 | 1.16 | .37 | .02 | 435 | .05 | 406 |
| AMIN-4166 | 4166 | 4/17/03 9:48 | FA | 183 | 1.19 | .38 | .002 | 434 | .02 | 371 |
| AMIN-4166 | 4166 | 4/17/03 9:48 | RA | 189 | 1.28 | .38 | .01 | 420 | .04 | 396 |
| AMIN-4166 | 4166 | 4/17/03 11:01 | FA | 180 | 1.24 | .39 | .003 | 439 | .02 | 351 |
| AMIN-4166 | 4166 | 4/17/03 11:01 | RA | 172 | 1.27 | .39 | .01 | 430 | .04 | 349 |
| AMIN-4166 | 4166 | 4/17/03 11:59 | FA | 170 | 1.23 | .64 | .01 | 447 | .03 | 327 |
| AMIN-4166 | 4166 | 4/17/03 11:59 | RA | 173 | 1.32 | .35 | .01 | 463 | .03 | 331 |
| AMIN-4166 | 4166 | 4/17/03 13:55 | FA | 157 | 1.12 | .34 | .01 | 420 | .02 | 311 |
| AMIN-4166 | 4166 | 4/17/03 13:55 | RA | 164 | 1.12 | .35 | .02 | 428 | .06 | 350 |
| AMIN-4916 | 4916 | 4/16/03 13:00 | FA | 576 | 2.42 | .59 | .01 | 447 | .05 | 313 |
| AMIN-4916 | 4916 | 4/16/03 13:00 | RA | 598 | 1.72 | .55 | .02 | 452 | .07 | 326 |
| AMIN-4916 | 4916 | 4/16/03 14:00 | FA | 507 | 1.47 | .65 | .01 | 435 | .04 | 277 |
| AMIN-4916 | 4916 | 4/16/03 14:00 | RA | 535 | 2.24 | .58 | .02 | 458 | .06 | 301 |
| AMIN-4916 | 4916 | 4/16/03 16:00 | FA | 532 | 1.47 | .58 | .01 | 444 | .07 | 325 |
| AMIN-4916 | 4916 | 4/16/03 16:00 | RA | 531 | 1.39 | .50 | .02 | 422 | .08 | 322 |
| AMIN-4916 | 4916 | 4/16/03 17:00 | FA | 521 | 1.46 | .56 | .005 | 428 | .05 | 328 |
| AMIN-4916 | 4916 | 4/16/03 17:00 | RA | 510 | 1.52 | .51 | .02 | 433 | .09 | 334 |
| AMIN-4916 | 4916 | 4/16/03 18:00 | FA | 530 | 1.43 | .59 | .004 | 431 | .04 | 327 |
| AMIN-4916 | 4916 | 4/16/03 18:00 | RA | 519 | 1.47 | .54 | .02 | 423 | .08 | 325 |
| AMIN-4916 | 4916 | 4/16/03 19:00 | FA | 533 | 1.48 | .59 | .01 | 431 | .04 | 354 |
| AMIN-4916 | 4916 | 4/16/03 19:00 | RA | 544 | 1.43 | .52 | .03 | 426 | .08 | 364 |
| AMIN-4916 | 4916 | 4/16/03 20:00 | FA | 540 | 1.42 | .62 | .01 | 425 | .03 | 381 |
| AMIN-4916 | 4916 | 4/16/03 20:00 | RA | 561 | 1.52 | .61 | .03 | 415 | .08 | 396 |
| AMIN-4916 | 4916 | 4/16/03 21:00 | FA | 557 | 1.38 | .64 | .005 | 429 | .03 | 437 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Manganese | Molybdenum | Nickel | Silver | Strontium | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-4916 | 4916 | 4/16/03 21:00 | RA | 559 | 1.46 | .54 | .03 | 411 | .07 | 448 |
| AMIN-4916 | 4916 | 4/16/03 22:00 | FA | 587 | 1.38 | .60 | .01 | 431 | .03 | 453 |
| AMIN-4916 | 4916 | 4/16/03 22:00 | RA | 578 | 1.41 | .55 | .02 | 431 | .06 | 464 |
| AMIN-4916 | 4916 | 4/16/03 23:00 | FA | 578 | 1.37 | .63 | .01 | 426 | .03 | 478 |
| AMIN-4916 | 4916 | 4/16/03 23:00 | RA | 580 | 1.40 | .54 | .02 | 410 | .06 | 477 |
| AMIN-4916 | 4916 | 4/17/03 0:00 | FA | 577 | 1.47 | .65 | .004 | 452 | .02 | 462 |
| AMIN-4916 | 4916 | 4/17/03 0:00 | RA | 596 | 1.44 | .57 | .02 | 431 | .06 | 464 |
| AMIN-4916 | 4916 | 4/17/03 1:00 | FA | 591 | 1.42 | .64 | .002 | 427 | .02 | 482 |
| AMIN-4916 | 4916 | 4/17/03 1:00 | RA | 586 | 1.42 | .56 | .02 | 425 | .06 | 485 |
| AMIN-4916 | 4916 | 4/17/03 8:50 | FA | 611 | 1.54 | .61 | .002 | 453 | .02 | 526 |
| AMIN-4916 | 4916 | 4/17/03 8:50 | RA | 591 | 1.49 | .58 | .01 | 440 | .04 | 541 |
| AMIN-4916 | 4916 | 4/17/03 9:57 | FA | 620 | 1.52 | .60 | .002 | 457 | .02 | 514 |
| AMIN-4916 | 4916 | 4/17/03 9:57 | RA | 617 | 1.54 | .57 | .01 | 437 | .04 | 538 |
| AMIN-4916 | 4916 | 4/17/03 11:08 | FA | 588 | 1.50 | .53 | .003 | 443 | .02 | 495 |
| AMIN-4916 | 4916 | 4/17/03 11:08 | RA | 616 | 1.52 | .54 | .01 | 434 | .04 | 521 |
| AMIN-4916 | 4916 | 4/17/03 12:06 | FA | 584 | 1.58 | .55 | .002 | 422 | .02 | 470 |
| AMIN-4916 | 4916 | 4/17/03 12:06 | RA | 593 | 1.64 | .52 | .02 | 452 | .04 | 471 |
| AMIN-4916 | 4916 | 4/17/03 14:02 | FA | 540 | 1.36 | .50 | .01 | 434 | .02 | 430 |
| AMIN-4916 | 4916 | 4/17/03 14:02 | RA | 555 | 1.48 | .55 | .03 | 454 | .18 | 455 |
| AMIN-5536 | 5536 | 4/16/03 13:00 | FA | 562 | 1.70 | .74 | .002 | 469 | .02 | 450 |
| AMIN-5536 | 5536 | 4/16/03 13:00 | RA | 956 | 1.62 | .71 | .01 | 470 | .04 | 490 |
| AMIN-5536 | 5536 | 4/16/03 14:00 | FA | 866 | 1.64 | .71 | .003 | 468 | .03 | 447 |
| AMIN-5536 | 5536 | 4/16/03 14:00 | RA | 856 | 1.47 | .63 | .01 | 443 | .05 | 454 |
| AMIN-5536 | 5536 | 4/16/03 15:00 | FA | 799 | 1.49 | .64 | .003 | 461 | .04 | 399 |
| AMIN-5536 | 5536 | 4/16/03 15:00 | RA | 809 | 1.34 | .57 | .01 | 444 | .07 | 409 |
| AMIN-5536 | 5536 | 4/16/03 16:00 | FA | 839 | 1.50 | .63 | .003 | 453 | .05 | 421 |
| AMIN-5536 | 5536 | 4/16/03 16:00 | RA | 806 | 1.38 | .62 | .01 | 439 | .09 | 423 |
| AMIN-5536 | 5536 | 4/16/03 17:00 | FA | 807 | 1.53 | .64 | .003 | 444 | .03 | 419 |
| AMIN-5536 | 5536 | 4/16/03 17:00 | RA | 796 | 1.46 | .59 | .03 | 432 | .05 | 434 |
| AMIN-5536 | 5536 | 4/16/03 18:00 | FA | 799 | 1.51 | .67 | .002 | 437 | .04 | 432 |
| AMIN-5536 | 5536 | 4/16/03 18:00 | RA | 819 | 1.47 | .58 | .01 | 419 | .07 | 464 |
| AMIN-5536 | 5536 | 4/16/03 19:00 | FA | 767 | 1.50 | .64 | .003 | 425 | .07 | 432 |
| AMIN-5536 | 5536 | 4/16/03 19:00 | RA | 784 | 1.40 | .61 | .02 | 414 | .12 | 448 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Manganese | Molybdenum | Nickel | Silver | Strontium | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-5536 | 5536 | 4/16/03 20:00 | FA | 804 | 1.49 | .77 | .004 | 435 | .06 | 481 |
| AMIN-5536 | 5536 | 4/16/03 20:00 | RA | 832 | 1.46 | .64 | .02 | 431 | .10 | 494 |
| AMIN-5536 | 5536 | 4/16/03 21:00 | FA | 854 | 1.59 | .74 | .003 | 441 | .04 | 515 |
| AMIN-5536 | 5536 | 4/16/03 21:00 | RA | 850 | 1.38 | .69 | .01 | 427 | .08 | 534 |
| AMIN-5536 | 5536 | 4/16/03 22:00 | FA | 876 | 1.44 | .72 | .002 | 436 | .03 | 525 |
| AMIN-5536 | 5536 | 4/16/03 22:00 | RA | 876 | 1.42 | .67 | .02 | 432 | .06 | 534 |
| AMIN-5536 | 5536 | 4/16/03 23:00 | FA | 882 | 1.30 | .60 | .002 | 383 | .04 | 543 |
| AMIN-5536 | 5536 | 4/16/03 23:00 | RA | 877 | 1.37 | .66 | .02 | 422 | .08 | 560 |
| AMIN-5536 | 5536 | 4/17/03 0:00 | FA | 888 | 1.40 | .75 | .003 | 427 | .03 | 559 |
| AMIN-5536 | 5536 | 4/17/03 0:00 | RA | 923 | 1.61 | .68 | .01 | 444 | .07 | 576 |
| AMIN-5536 | 5536 | 4/17/03 1:00 | FA | 904 | 1.50 | .72 | .002 | 450 | .02 | 547 |
| AMIN-5536 | 5536 | 4/17/03 1:00 | RA | 911 | 2.12 | .66 | .02 | 431 | .05 | 556 |
| AMIN-5536 | 5536 | 4/17/03 9:06 | FA | 927 | 1.64 | .71 | .002 | 455 | .02 | 564 |
| AMIN-5536 | 5536 | 4/17/03 9:06 | RA | 954 | 1.83 | .67 | .02 | 446 | .04 | 575 |
| AMIN-5536 | 5536 | 4/17/03 10:07 | FA | 902 | 1.52 | .66 | .003 | 442 | .02 | 528 |
| AMIN-5536 | 5536 | 4/17/03 10:07 | RA | 913 | 1.52 | .64 | .01 | 458 | .04 | 563 |
| AMIN-5536 | 5536 | 4/17/03 11:13 | FA | 963 | 1.57 | .71 | .004 | 456 | .02 | 540 |
| AMIN-5536 | 5536 | 4/17/03 11:13 | RA | 929 | 1.55 | .72 | .01 | 463 | .04 | 542 |
| AMIN-5536 | 5536 | 4/17/03 12:14 | FA | 903 | 1.68 | .65 | .002 | 429 | .02 | 652 |
| AMIN-5536 | 5536 | 4/17/03 12:14 | RA | 949 | 1.66 | .70 | .01 | 428 | .04 | 536 |
| AMIN-5536 | 5536 | 4/17/03 14:10 | FA | 833 | 1.51 | .64 | .01 | 469 | .03 | 452 |
| AMIN-5536 | 5536 | 4/17/03 14:10 | RA | 854 | 1.54 | .74 | .04 | 464 | .26 | 474 |
| AMIN-6745 | 6745 | 4/16/03 13:00 | FA | 1,500 | 1.49 | 1.05 | .001 | 451 | .06 | 532 |
| AMIN-6745 | 6745 | 4/16/03 13:00 | RA | 1,560 | 1.63 | 1.26 | .02 | 482 | .12 | 594 |
| AMIN-6745 | 6745 | 4/16/03 14:00 | FA | 1,390 | 1.49 | 1.10 | .002 | 468 | .08 | 487 |
| AMIN-6745 | 6745 | 4/16/03 14:00 | RA | 1,370 | 1.60 | 1.05 | .01 | 467 | .12 | 508 |
| AMIN-6745 | 6745 | 4/16/03 15:00 | FA | 1,260 | 1.52 | .99 | .003 | 466 | .05 | 411 |
| AMIN-6745 | 6745 | 4/16/03 15:00 | RA | 1,250 | 1.57 | .95 | .03 | 471 | .11 | 429 |
| AMIN-6745 | 6745 | 4/16/03 16:00 | FA | 1,240 | 1.37 | 1.00 | .003 | 447 | .07 | 415 |
| AMIN-6745 | 6745 | 4/16/03 16:00 | RA | 1,280 | 1.47 | .94 | .02 | 463 | .13 | 445 |
| AMIN-6745 | 6745 | 4/16/03 17:00 | FA | 1,280 | 1.37 | 1.08 | .002 | 445 | .05 | 438 |
| AMIN-6745 | 6745 | 4/16/03 17:00 | RA | 1,300 | 1.46 | .93 | .03 | 459 | .12 | 462 |
| AMIN-6745 | 6745 | 4/16/03 18:00 | FA | 1,270 | 1.42 | 1.03 | .002 | 457 | .05 | 459 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Manganese | Molybdenum | Nickel | Silver | Strontium | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-6745 | 6745 | 4/16/03 18:00 | RA | 1,280 | 1.52 | .99 | .03 | 455 | .15 | 499 |
| AMIN-6745 | 6745 | 4/16/03 19:00 | FA | 1,260 | 1.49 | 1.07 | .003 | 452 | .06 | 464 |
| AMIN-6745 | 6745 | 4/16/03 19:00 | RA | 1,250 | 1.51 | .95 | .03 | 449 | .15 | 492 |
| AMIN-6745 | 6745 | 4/16/03 20:00 | FA | 1,260 | 1.45 | 1.18 | .002 | 461 | .05 | 505 |
| AMIN-6745 | 6745 | 4/16/03 20:00 | RA | 1,280 | 1.47 | 1.10 | .03 | 439 | .16 | 533 |
| AMIN-6745 | 6745 | 4/16/03 21:00 | FA | 1,330 | 1.44 | 1.16 | .002 | 451 | .06 | 577 |
| AMIN-6745 | 6745 | 4/16/03 21:00 | RA | 1,310 | 1.47 | 1.11 | .03 | 448 | .13 | 587 |
| AMIN-6745 | 6745 | 4/16/03 22:00 | FA | 1,290 | 1.47 | 1.12 | .004 | 456 | .05 | 585 |
| AMIN-6745 | 6745 | 4/16/03 22:00 | RA | 1,300 | 1.45 | 1.06 | .02 | 446 | .12 | 607 |
| AMIN-6745 | 6745 | 4/16/03 23:00 | FA | 1,270 | 1.38 | 1.14 | .001 | 433 | .05 | 581 |
| AMIN-6745 | 6745 | 4/16/03 23:00 | RA | 1,260 | 1.64 | 1.12 | .02 | 451 | .11 | 617 |
| AMIN-6745 | 6745 | 4/17/03 0:00 | FA | 1,310 | 1.39 | 1.15 | .003 | 452 | .04 | 599 |
| AMIN-6745 | 6745 | 4/17/03 0:00 | RA | 1,320 | 1.48 | 1.09 | .04 | 451 | .12 | 621 |
| AMIN-6745 | 6745 | 4/17/03 1:00 | FA | 1,300 | 1.40 | 1.15 | .002 | 448 | .05 | 603 |
| AMIN-6745 | 6745 | 4/17/03 1:00 | RA | 1,370 | 1.49 | 1.13 | .03 | 469 | .11 | 665 |
| AMIN-6745 | 6745 | 4/17/03 2:00 | FA | 1,330 | 1.38 | 1.10 | .002 | 450 | .04 | 611 |
| AMIN-6745 | 6745 | 4/17/03 2:00 | RA | 1,270 | 2.14 | 1.16 | .03 | 454 | .10 | 612 |
| AMIN-6745 | 6745 | 4/17/03 3:00 | FA | 1,310 | 1.35 | 1.16 | .002 | 444 | .04 | 609 |
| AMIN-6745 | 6745 | 4/17/03 3:00 | RA | 1,340 | 1.46 | 1.08 | .02 | 448 | .11 | 630 |
| AMIN-6745 | 6745 | 4/17/03 4:00 | FA | 1,370 | 1.50 | 1.14 | .004 | 466 | .04 | 639 |
| AMIN-6745 | 6745 | 4/17/03 4:00 | RA | 1,320 | 1.56 | 1.09 | .02 | 464 | .08 | 627 |
| AMIN-6745 | 6745 | 4/17/03 5:00 | FA | 1,380 | 1.34 | 1.13 | .002 | 458 | .02 | 586 |
| AMIN-6745 | 6745 | 4/17/03 5:00 | RA | 1,330 | 1.51 | 1.07 | .02 | 457 | .07 | 586 |
| AMIN-6745 | 6745 | 4/17/03 6:00 | FA | 1,330 | 1.38 | 1.24 | .002 | 450 | .03 | 564 |
| AMIN-6745 | 6745 | 4/17/03 6:00 | RA | 1,350 | 1.42 | 1.03 | .03 | 452 | .10 | 601 |
| AMIN-6745 | 6745 | 4/17/03 7:00 | FA | 1,350 | 1.49 | 1.38 | .003 | 469 | .03 | 644 |
| AMIN-6745 | 6745 | 4/17/03 7:00 | RA | 1,360 | 1.52 | 1.16 | .02 | 476 | .14 | 643 |
| AMIN-6745 | 6745 | 4/17/03 9:17 | FA | 1,400 | 1.48 | 1.07 | .001 | 462 | .01 | 676 |
| AMIN-6745 | 6745 | 4/17/03 9:17 | RA | 1,380 | 1.50 | 1.08 | .02 | 464 | .05 | 654 |
| AMIN-6745 | 6745 | 4/17/03 10:16 | FA | 1,480 | 1.49 | 1.14 | .002 | 472 | .01 | 666 |
| AMIN-6745 | 6745 | 4/17/03 10:16 | RA | 1,530 | 1.50 | 1.13 | .01 | 483 | .04 | 688 |
| AMIN-6745 | 6745 | 4/17/03 11:23 | FA | 1,440 | 1.59 | 1.14 | .002 | 487 | .01 | 640 |
| AMIN-6745 | 6745 | 4/17/03 11:23 | RA | 1,460 | 1.70 | 1.21 | .01 | 510 | .04 | 653 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Manganese | Molybdenum | Nickel | Silver | Strontium | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-6745 | 6745 | 4/17/03 12:20 | FA | 1,400 | 1.55 | 1.04 | .001 | 469 | .02 | 644 |
| AMIN-6745 | 6745 | 4/17/03 12:20 | RA | 1,460 | 1.55 | 1.08 | .01 | 485 | .04 | 654 |
| AMIN-6745 | 6745 | 4/17/03 14:16 | FA | 1,310 | 1.48 | 1.00 | .002 | 491 | .02 | 560 |
| AMIN-6745 | 6745 | 4/17/03 14:16 | RA | 1,260 | 1.46 | .98 | .02 | 468 | .05 | 577 |
| AMIN-7306 | 7306 | 4/16/03 13:00 | FA | 1,540 | 1.60 | 1.18 | .001 | 485 | .01 | 598 |
| AMIN-7306 | 7306 | 4/16/03 13:00 | RA | 1,520 | 1.55 | 1.13 | .01 | 484 | .05 | 623 |
| AMIN-7306 | 7306 | 4/16/03 14:00 | FA | 1,450 | 1.56 | 1.11 | .002 | 484 | .02 | 552 |
| AMIN-7306 | 7306 | 4/16/03 14:00 | RA | 1,440 | 1.61 | 1.06 | .02 | 488 | .05 | 571 |
| AMIN-7306 | 7306 | 4/16/03 15:00 | FA | 1,330 | 1.56 | 1.05 | .003 | 490 | .02 | 507 |
| AMIN-7306 | 7306 | 4/16/03 15:00 | RA | 1,290 | 1.59 | 1.00 | .01 | 490 | .05 | 535 |
| AMIN-7306 | 7306 | 4/16/03 16:00 | FA | 1,240 | 1.39 | 1.03 | .002 | 481 | .04 | 440 |
| AMIN-7306 | 7306 | 4/16/03 16:00 | RA | 1,320 | 1.43 | 1.05 | .02 | 476 | .10 | 502 |
| AMIN-7306 | 7306 | 4/16/03 17:00 | FA | 1,260 | 1.49 | 1.18 | .003 | 471 | .03 | 515 |
| AMIN-7306 | 7306 | 4/16/03 17:00 | RA | 1,260 | 1.53 | 1.11 | .02 | 466 | .09 | 533 |
| AMIN-7306 | 7306 | 4/16/03 18:00 | FA | 1,280 | 1.49 | 1.09 | .01 | 468 | .02 | 518 |
| AMIN-7306 | 7306 | 4/16/03 18:00 | RA | 1,250 | 1.55 | 1.10 | .03 | 452 | .10 | 536 |
| AMIN-7306 | 7306 | 4/16/03 19:00 | FA | 1,250 | 1.45 | 1.04 | .01 | 449 | .02 | 527 |
| AMIN-7306 | 7306 | 4/16/03 19:00 | RA | 1,230 | 1.48 | 1.01 | .01 | 454 | .07 | 551 |
| AMIN-7306 | 7306 | 4/16/03 20:00 | FA | 1,270 | 1.43 | 1.08 | .002 | 461 | .02 | 564 |
| AMIN-7306 | 7306 | 4/16/03 20:00 | RA | 1,280 | 1.49 | 1.07 | .02 | 446 | .07 | 588 |
| AMIN-7306 | 7306 | 4/16/03 21:00 | FA | 1,310 | 1.36 | 1.06 | .003 | 446 | .02 | 590 |
| AMIN-7306 | 7306 | 4/16/03 21:00 | RA | 1,310 | 1.47 | 1.06 | .02 | 445 | .07 | 622 |
| AMIN-7306 | 7306 | 4/16/03 22:00 | FA | 1,360 | 1.40 | 1.11 | .002 | 467 | .02 | 633 |
| AMIN-7306 | 7306 | 4/16/03 22:00 | RA | 1,290 | 1.54 | 1.11 | .02 | 465 | .07 | 649 |
| AMIN-7306 | 7306 | 4/16/03 23:00 | FA | 1,370 | 1.44 | 1.25 | .001 | 449 | .01 | 657 |
| AMIN-7306 | 7306 | 4/16/03 23:00 | RA | 1,320 | 1.44 | 1.06 | .02 | 438 | .06 | 657 |
| AMIN-7306 | 7306 | 4/17/03 0:00 | FA | 1,360 | 1.45 | 1.14 | .004 | 470 | .01 | 647 |
| AMIN-7306 | 7306 | 4/17/03 0:00 | RA | 1,350 | 1.46 | 1.09 | .02 | 461 | .06 | 686 |
| AMIN-7306 | 7306 | 4/17/03 9:23 | FA | 1,420 | 1.40 | 1.13 | .001 | 480 | .01 | 659 |
| AMIN-7306 | 7306 | 4/17/03 9:23 | RA | 1,450 | 1.38 | 1.08 | .02 | 462 | .05 | 704 |
| AMIN-7306 | 7306 | 4/17/03 10:27 | RA | 1,480 | 1.47 | 1.07 | .01 | 453 | .03 | 692 |
| AMIN-7306 | 7306 | 4/17/03 11:29 | FA | 1,500 | 1.44 | 1.16 | .001 | 493 | .01 | 667 |
| AMIN-7306 | 7306 | 4/17/03 11:29 | RA | 1,490 | 2.09 | 1.15 | .02 | 488 | .04 | 695 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Manganese | Molybdenum | Nickel | Silver | Strontium | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-7306 | 7306 | 4/17/03 12:26 | FA | 1,480 | 1.60 | 1.15 | .001 | 480 | .01 | 636 |
| AMIN-7306 | 7306 | 4/17/03 12:26 | RA | 1,500 | 1.62 | 1.16 | .02 | 523 | .07 | 651 |
| AMIN-7306 | 7306 | 4/17/03 14:22 | FA | 1,250 | 1.60 | .99 | .001 | 451 | .01 | 568 |
| AMIN-7306 | 7306 | 4/17/03 14:22 | RA | 1,320 | 1.93 | .99 | .02 | 442 | .05 | 579 |
| AMIN-7858 | 7858 | 4/16/03 13:00 | FA | 2,040 | 1.69 | 1.40 | .003 | 516 | .03 | 616 |
| AMIN-7858 | 7858 | 4/16/03 13:00 | RA | 2,050 | 1.57 | 1.41 | .02 | 517 | .07 | 641 |
| AMIN-7858 | 7858 | 4/16/03 14:00 | FA | 2,120 | 1.63 | 1.44 | .002 | 504 | .04 | 593 |
| AMIN-7858 | 7858 | 4/16/03 14:00 | RA | 2,160 | 1.66 | 1.52 | .06 | 524 | .21 | 660 |
| AMIN-7858 | 7858 | 4/16/03 17:00 | FA | 2,020 | 1.34 | 1.39 | .003 | 463 | .02 | 548 |
| AMIN-7858 | 7858 | 4/16/03 17:00 | RA | 2,030 | 1.34 | 1.41 | .02 | 502 | .06 | 566 |
| AMIN-7858 | 7858 | 4/16/03 18:00 | FA | 1,840 | 1.30 | 1.34 | .001 | 472 | .03 | 538 |
| AMIN-7858 | 7858 | 4/16/03 18:00 | RA | 1,850 | 1.35 | 1.36 | .02 | 492 | .07 | 569 |
| AMIN-7858 | 7858 | 4/16/03 19:00 | FA | 1,780 | 1.36 | 1.35 | .002 | 461 | .02 | 547 |
| AMIN-7858 | 7858 | 4/16/03 19:00 | RA | 1,850 | 1.36 | 1.30 | .02 | 468 | .07 | 600 |
| AMIN-7858 | 7858 | 4/16/03 20:00 | FA | 1,760 | 1.50 | 1.42 | .002 | 480 | .02 | 605 |
| AMIN-7858 | 7858 | 4/16/03 20:00 | RA | 1,780 | 1.35 | 1.34 | .02 | 478 | .08 | 614 |
| AMIN-7858 | 7858 | 4/16/03 21:00 | FA | 1,860 | 1.29 | 1.36 | .01 | 465 | .02 | 651 |
| AMIN-7858 | 7858 | 4/16/03 21:00 | RA | 1,780 | 1.34 | 1.34 | .02 | 473 | .07 | 630 |
| AMIN-7858 | 7858 | 4/16/03 22:00 | FA | 1,760 | 1.37 | 1.39 | .004 | 449 | .02 | 666 |
| AMIN-7858 | 7858 | 4/16/03 22:00 | RA | 1,780 | 1.33 | 1.35 | .02 | 471 | .07 | 678 |
| AMIN-7858 | 7858 | 4/16/03 23:00 | FA | 1,750 | 1.41 | 1.34 | .01 | 491 | .02 | 674 |
| AMIN-7858 | 7858 | 4/16/03 23:00 | RA | 1,760 | 1.48 | 1.40 | .02 | 497 | .07 | 704 |
| AMIN-7858 | 7858 | 4/17/03 0:00 | FA | 1,650 | 1.35 | 1.31 | .001 | 457 | .03 | 658 |
| AMIN-7858 | 7858 | 4/17/03 0:00 | RA | 1,740 | 1.38 | 1.31 | .02 | 478 | .07 | 697 |
| AMIN-7858 | 7858 | 4/17/03 1:00 | FA | 1,720 | 1.43 | 1.28 | .002 | 471 | .02 | 726 |
| AMIN-7858 | 7858 | 4/17/03 1:00 | RA | 1,680 | 1.42 | 1.30 | .02 | 479 | .06 | 697 |
| AMIN-7858 | 7858 | 4/17/03 2:00 | FA | 1,750 | 1.40 | 1.30 | .001 | 454 | .02 | 691 |
| AMIN-7858 | 7858 | 4/17/03 2:00 | RA | 1,790 | 1.35 | 1.27 | .02 | 468 | .06 | 707 |
| AMIN-7858 | 7858 | 4/17/03 3:00 | FA | 1,760 | 1.38 | 1.32 | .001 | 464 | .02 | 704 |
| AMIN-7858 | 7858 | 4/17/03 3:00 | RA | 1,750 | 1.30 | 1.24 | .01 | 477 | .07 | 711 |
| AMIN-7858 | 7858 | 4/17/03 4:00 | FA | 1,780 | 1.32 | 1.31 | .01 | 477 | .02 | 716 |
| AMIN-7858 | 7858 | 4/17/03 4:00 | RA | 1,680 | 1.33 | 1.27 | .01 | 481 | .06 | 689 |

Table S2. Chemical analyses of high-flow temporal samples, Animas River, April 2003
[Filter: FA, 0.45-micrometer, RA, total recoverable; L/s, liters per second; mg/L, milligrams per liter; ug/L, micrograms per l iter; Sodium bromide injected tracer]

| Site | Distance | Time | Filter | Manganese | Molybdenum | Nickel | Silver | Strontium | Vanadium | Zinc |
|---|---|---|---|---|---|---|---|---|---|---|
| | meters | | | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L | ug/L |
| AMIN-7858 | 7858 | 4/17/03 5:00 | FA | 1,740 | 1.30 | 1.32 | .001 | 476 | .02 | 701 |
| AMIN-7858 | 7858 | 4/17/03 5:00 | RA | 1,730 | 1.37 | 1.23 | .01 | 479 | .05 | 702 |
| AMIN-7858 | 7858 | 4/17/03 6:00 | FA | 1,710 | 1.31 | 1.33 | .002 | 477 | .02 | 673 |
| AMIN-7858 | 7858 | 4/17/03 6:00 | RA | 1,750 | 1.37 | 1.25 | .01 | 480 | .05 | 715 |
| AMIN-7858 | 7858 | 4/17/03 9:23 | FA | 1,880 | 1.42 | 1.36 | .004 | 516 | .01 | 720 |
| AMIN-7858 | 7858 | 4/17/03 9:23 | RA | 1,870 | 1.43 | 1.35 | .02 | 497 | .05 | 741 |
| AMIN-7858 | 7858 | 4/17/03 10:38 | FA | 1,970 | 1.45 | 1.37 | .001 | 510 | .01 | 703 |
| AMIN-7858 | 7858 | 4/17/03 10:38 | RA | 1,980 | 1.49 | 1.39 | .01 | 498 | .04 | 755 |
| AMIN-7858 | 7858 | 4/17/03 11:35 | FA | 1,900 | 1.50 | 1.42 | .005 | 501 | .01 | 689 |
| AMIN-7858 | 7858 | 4/17/03 11:35 | RA | 1,950 | 1.48 | 1.38 | .02 | 498 | .05 | 710 |
| AMIN-7858 | 7858 | 4/17/03 12:45 | FA | 1,890 | 1.54 | 1.36 | .003 | 487 | .01 | 661 |
| AMIN-7858 | 7858 | 4/17/03 12:45 | RA | 1,940 | 1.52 | 1.33 | .02 | 506 | .04 | 683 |
| AMIN-7858 | 7858 | 4/17/03 14:32 | FA | 1,760 | 1.54 | 1.25 | .01 | 502 | .01 | 614 |
| AMIN-7858 | 7858 | 4/17/03 14:32 | RA | 1,850 | 1.48 | 1.27 | .02 | 500 | .05 | 674 |